(1) பக்கங்களின் எண்ணிக்கை 192 கிடைத்தது

(2) புழங்கத் திரும்பிய நாள் 10-8-88

(3) ஆசாரஞ்சரிபார்த்த கருக்கொப்பம்

தமிழ்நாடு ஆவணக் காப்பகம்.

தமிழ்நாடு அரசு

திருநெல்வேலி மாவட்டம்

அலகுப் எண். 36447
மு. கோப்புத் தாள் எண். 3645

அலகுப் பெயர்

நாள் : 17-11-1888 19 .

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1

GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

Buildings and Roads.
Civil Works.

Read—the following paper :—

From R. W. BARLOW, Esq., C.S., Chairman, Harbour Trust Board, to the Chief Secretary to Government, Marine Department, dated Madras, 19th October 1888, No. 2455.

I have the honor to acknowledge the receipt of G.O., No. 2255 W., Public Works, dated 1st August 1888, and to submit herewith, for the information of Government, copy of letter No. 902, dated 1st October 1888, from the Board's Engineer furnishing all details that the late Superintendent has left on record with regard to No. III design, and further forwarding his report, plans and estimates for carrying out a modification of plan IV; also copy of a resolution passed thereon by the Trustees at their meeting of 5th idem, in accordance with which a telegram was despatched to you that evening, copy of which is enclosed.

2. In my letter No. 69, dated 6th April 1888, para. 7, I informed Government that the Trustees preferred "plan No. III, but * * * any modification of plan III or IV, or any plan, which will give them * * * this (smooth water) within a reasonable time, at a cost which the port can afford to pay, is all they have contended for as being absolutely necessary." The contracts now to be removed to carry out plan No. III has never until now been clearly explained to the Trustees, nor has the good protection the old, partly submerged, wall will afford to the new work ever before been clearly demonstrated, as has now been done, in the cross section shown on the plan forwarded herewith, and the Board are now of opinion, in view of this very clear information afforded by their Engineer, that the danger of repeated breakages of dredging plant, and the uncertainty as to the time of completion, are fatal objections to Mr. Thornycroft's proposals, although approved by the Home Committee, who, however, were not in possession of the information now placed before the Board, and only approved of plan No. III on another ground.

3. The Trustees observe that in his note, dated 27th June 1888, the Honorable Colonel Hutchinson remarks that "It may possibly prove, as the best way of completing the harbour expeditiously, that the southern arm should be nearly completed on the lines of the present design, so that one crane could be used in constructing the protecting arm of the Committee's approved plan while another is pushing on the southern arm, but it can hardly be the most economical plan, and it should be considered, if this method of working is to be adopted, whether the section of the work, which would only have to stand for a year or two, should not be modified with a view to the easy removal of the blocks as soon as the protecting arm is completed." The Trust now note that Mr. Pigeon's proposals for carrying this suggestion into effect would appear to be not only the most expeditious, but also the most economical. I should mention, here, that a sketch of the modification of the design of the proposed completed entrance, No. IV A, has been shown to Sir Guilford Molesworth by one of the Trustees, Mr. Hanna, M.I.C.E., now at Simla, and has met with his "entire approval," and Sir Guilford has authorized me by wire to use this expression of his opinion.

4. The Trustees unanimously approve of Mr. Pogson's proposals for a north-east entrance and prefer his plan to all others that have come before them. As regards his remarks at para. 27, the Trust can have no possible objection to this plan affording as it progresses further practical information as to what would be the effect of an eastern entrance when completed. If, then, it is found that an eastern entrance will not give sufficiently smooth water, the Board are unanimously of opinion that plan No. IV A should be adopted, if the financial position of the port will admit of it. Smooth water is essential, and if they obtain this, as they have clearly expressed themselves in their No. 69, dated 6th April 1888, the precise plan by which that result can be obtained is a matter of comparative indifference; but the one now submitted seems more likely than any other, to effect this economically, by using the debris of the old submerged works, as well as utilizing the shelter afforded by it, and the Board have therefore adopted it; and if Government approve of the Board's resolution, I am desired to request that the matter may be referred to the Secretary of State for sanction and that his decision may be communicated by wire, so that the Trustees may be in a position to direct Mr. Pogson to resume work upon the sanctioned design at the north arm immediately the conclusion of the coming north-east monsoon renders active operations practicable.

Transferred to the Public Works Department.

(By order.)

24th October 1888.

(Signed) W. S. MEYER,
Ag. Assistant Secretary.

ORDER—dated 17th November 1888, No. 3644 W., Public Works.

The Right Honorable the Governor in Council resolves to submit the papers forwarded by the Harbour Trust Board to the Secretary of State for decision. The plan proposed is in accordance with Mr. Parkes' suggestions and merits much consideration.

2. Ordered that the Secretary of State be addressed.

(True Extract.)

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

To the Chairman, Harbour Trust Board.
" Marine Department.

Exd. J. Henriens.
Spare Copies

BUILDINGS AND ROADS.
CIVIL WORKS.

Govt. of [1888] Madras.

PUBLIC WORKS.

Dated November, 17th.

Read. *Encl.*

G.O., 17th Nov. 1888, No. 3644 W.

NOVEMBER.

Madras Harbour

Ordered that the Secretary of State be addressed on the proposals of the Harbour Trust Board for completing the —.

PUBLIC WORKS DEPARTMENT.

Buildings and Roads.
Civil Works.

LETTER—from

COLONEL H. R. MEAD, R.E.,
Ag. 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 forward herewith, for the information of the Government of India, a copy of the Proceedings of this Government, No. 3644 W., dated 17th November 1888, together with copy of the despatch to the Right Honorable the Secretary of State submitting proposals for the completion of the Madras Harbour Works.

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

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

MADRAS,
17th November 1888.

Exd. J. Henricus.
Spare Copies

BUILDINGS AND ROADS.
CIVIL WORKS.

Govt. of {1888} Madras.

PUBLIC WORKS.

Dated November, 17*th*.

Read. *Encl*s

17th Nov. 1888, No. 3645 W.

NOVEMBER.

Madras Harbour

Forwarding copy of Proceedings, together with copy of despatch, to the Right Honorable the Secretary of State submitting proposals for the completion of the —.

PUBLIC WORKS DEPARTMENT.

LETTER—to

THE RIGHT HONORABLE THE SECRETARY OF STATE FOR INDIA,

LONDON.

MY LORD,

In continuation of our despatch, dated the 1st August 1888, regarding the Madras Harbour, we have the honor to forward a letter from the Harbour Trust Board submitting their detailed proposals, with plans and estimates, for completing the Madras Harbour.

2. It will be observed that the Harbour Trust Board prefer on engineering grounds a form of entrance based on plan marked IV in the Report of the Committee of 1887, or plan A in Mr. Parkes' letter * of the 25th November 1887, and propose to carry out the work according to Mr. Parkes' suggestion made in paras. 30 to 34 of his letter; that is to say, they propose as a first step virtually to restore the harbour to the state it was in previous to the storm of November 1881 with an eastern entrance. Should it then be found that the eastern entrance does not give sufficiently smooth water, the north-east entrance can be gradually substituted without serious engineering difficulties, and during the period of alteration from the eastern to the north-east entrance the usefulness of the harbour will be in no way impaired.

* *Vide* despatch from the Secretary of State, No. 11, Public Works, dated 15th December 1887.

3. The proposals of the Harbour Trust Board are clear and appear to us to contain all the information necessary to enable your Lordship to arrive at a decision as to the manner in which work on the harbour should now be resumed; and we would point out that, although the Committee of 1887 preferred plan No. III on *nautical grounds*, we believe that no exception on such grounds can be taken to the new plan No. IV A, while the arguments in favor of its adoption, on engineering grounds, are very strong.

4. In conclusion, we would ask that your Lordship's decision as to the preliminary step of restoring the harbour with an eastern entrance may be communicated to

us by wire, as it is of the greatest importance that none of the next working season be lost.

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

(Signed) CONNEMARA.
(„) C. G. MASTER.
(„) H. E. STOKES.

MADRAS,
17th November 1888.

Exd. J. Henrious.

GOVT. OF MADRAS.

PUBLIC WORKS DEPARTMENT.

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

No. $\frac{24}{3644\ W.}$, dated 17th Nov. 1888.

Forwarding, with remarks, letter from the Harbour Trust Board submitting detailed proposals with plans and estimates for completing the —.

GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

Buildings and Roads.
Civil Works.

READ—the following letter from R. W. BARLOW, Esq., C.S., Chairman, Harbour Trust Board, to the Chief Secretary to Government, Marine Department, dated Madras, 9th June 1888, No. 909 :—

In continuation of my letter No. 568, dated 14th May 1888, I have the honor to submit herewith, for the information and orders of Government, copies of the following letters :—

No. 243, dated 18th May, from Mr. Thorowgood, Engineer to the Harbour Trust Board, forwarding an application from Mr. A. Lee Pogson, Assistant Engineer, for promotion to the post of Engineer, rendered vacant by Mr. Thorowgood's resignation of the appointment.

I also submit herewith copy of resolution passed thereon by the trustees at their meeting of 29th May, confirmed last Tuesday, unanimously appointing Mr. Pogson to the post of Engineer to the Board from the date Mr. Thorowgood may give over charge, probably 1st August, upon a salary of Rs. 850, rising to Rs. 1,000 by annual increments of Rs. 50 per mensem ; the trustees being of opinion that the pay of the appointment should not exceed that amount.

2. Mr. Pogson has signified his acceptance of the appointment.

3. In coming to the decision to appoint Mr. Pogson, the Board have taken into consideration the recommendation of their Engineer Mr. Thorowgood, who, it will be observed, writes in his letter, No. 243, that, "I cannot think that a better selection could be made," and strongly support Mr. Pogson's claim, "feeling sure that he will be found equal to the duties of the post."

4. The proposed salary has been fixed after careful consideration of the emoluments of the various grades of Public Works engineers.

5. Mr. Pogson is now the same age that Mr. Thorowgood was when, in 1876, he assumed charge of the Harbour Works upon the death of Mr. May, and in addition to being in every way, in the opinion of the Board, well qualified, he has the additional advantage of having already had six years' connection with these works ; he has a thorough personal knowledge of them, and of the position and condition of the ruined walls below water, which is of very great importance to the successful completion of the new works, and is "thoroughly acquainted with the handling of the cranes." It is also a very important advantage his having already been several times temporarily in charge, and having proved his ability to work well and harmoniously with the staff of Europeans attached to the works, over whom he has shown that he has complete control.

6. I have therefore the honor to request that sanction may be accorded to the appointment under Section 24 of Act II of 1886, and shall be glad to receive the orders of Government at an early date, to enable Mr. Thorowgood to make arrangements for leaving India.

ENCLOSURES.

From F. N. THOROWGOOD, Esq., Engineer, Harbour Trust Board, to the Chairman, Harbour Trust Board, dated Madras, 18th May 1888, No. 243.

I have the honor to submit, herewith, a letter addressed to me by Mr. A. L. Pogson, in which he very reasonably asks to be promoted to the post of Engineer of the Harbour Trust Board and of Superintendent of the Harbour Works.

2. I cannot think that a better selection could be made than Mr. Pogson, as he knows the works well, and is thoroughly acquainted with the handling of the cranes, which want most careful management.

3. I therefore strongly support Mr. Pogson's claim, feeling sure that he will be found equal to the duties of the post he seeks.

From A. LEE POGSON, Esq., Assistant Superintendent, Madras Harbour Works, to the Superintendent, Madras Harbour Works, dated Madras, 16th May 1888, No. 241.

I have the honor to ask that you will be good enough to send in an application recommending my promotion to that of the post you have now resigned, viz., Engineer to the Harbour Trust Board, as I find from the Proceedings of the Harbour Trust Board, dated Friday, 11th instant, that your resignation has been accepted.

2. As to my career on these works, all is well known to yourself and the Harbour Trust Board, and it would be superfluous for me to go further than to mention that the Harbour Trust Board in their letter No. 5082, of November 1887, and Proceedings of Friday, 25th November 1887, No. 8 (copies enclosed), showed themselves to be thoroughly satisfied with the way in which I carried on the works, single handed, for 4½ months during your absence on leave, and that during my connection with these works (since February 1882) I have held charge on three separate occasions; and considering that next to yourself, I feel I am better acquainted with the general routine of the works and what is below water-level than any one else, I make this application for promotion without the slightest hesitation; and trust that the Harbour Trust Board will give it every consideration before appointing an entire stranger on these works at such an advanced stage.

From R. W. BARLOW, Esq., C.S., Chairman, Harbour Trust Board, to the Assistant Superintendent, Madras Harbour Works, dated Madras, 28th November 1887, No. 5082.

I have the honor to forward herewith extract of Proceedings of the Harbour Trust Board at their last meeting in recording the Superintendent's Progress Report for October, forwarded with his letter No. 1006, dated 14th instant, as you will no doubt be glad to find that the trustees have appreciated the efficient manner in which you have carried on the Harbour Works during Mr. Thorowgood's absence.

Extract of Proceedings of the Trustees of the Harbour of Madras, at a Meeting held at the offices of the Board on Friday the 25th November 1887.

* * * * *

8. Read letter from the Superintendent, Madras Harbour Works, No. 1006, dated 14th November 1887, submitting report of progress made on the Madras Harbour Works during the month of October 1887, with a plan.

Read Minute by the Chairman.

Recorded. The Board concur in Mr. Thorowgood's remarks regarding the efficient manner in which Mr. Pogson has carried on the works during the Superintendent's absence.

* * * * *

(Signed) C. PINSENT,
Secretary, Harbour Trust Board.

Extract of Proceedings of the Trustees of the Harbour of Madras, at a Meeting held at the offices of the Board on Tuesday the 29th May 1888.

* * * * *

5. Read letter from the Engineer, Harbour Trust Board, No. 243, dated 18th May 1888, forwarding letter from Mr. A. Lee Pogson, asking the trustees to promote him to the post of Engineer to the Harbour Trust Board.

Read Minutes by Captain W. L. C. Baddeley, R.E., and Mr. J. R. Hunter.

Resolved that Mr. A. Lee Pogson be appointed Engineer to the Board, subject to the approval of Government under Section 24 of Act II of 1886, and that the pay of the appointment be fixed at Rs. 850 per mensem, rising to Rs. 1,000 by annual increments of Rs. 50 per month; to take effect from the date of Mr. Thorowgood giving over charge.

* * * * *

(Signed) C. PINSENT,
Secretary, Harbour Trust Board.

Transferred to the Public Works Department.

(Signed) H. E. STOKES,
Chief Secretary.

12th June 1888.

ORDER—dated 18th June 1888, No. 1804 W., Public Works.

The proposed appointment of Mr. Pogson is sanctioned provisionally, pending settlement of the question of the north-east entrance to the Harbour.

(True Extract.)

(Signed) J. O. HASTED, Colonel, R.E.,
Secretary to Govt., P.W.D.

To the Chairman, Harbour Trust Board.
" Marine Department.

Ed. F. R. Bantleman.
Spare Copies.

BUILDINGS AND ROADS.
CIVIL WORKS.

Govt. of {1888} Madras

PUBLIC WORKS.

Dated June, 18th.

Read. *Ex*

G.O., 18th June 1888, No. 1804 W

JUNE.

Madras Harbour Works

The proposed appointment of Mr. Le
Pogson as Engineer of the Harbour Trus
Board and of Superintendent of the —, sanc
tioned provisionally pending settlement
the question of the north-east entrance
the Harbour.

8

GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

General.
Establishment.

READ—the following paper :—

Despatch from the Right Honorable VISCOUNT CROSS, Her Majesty's Secretary of State for India, to His Excellency the Right Honorable the Governor in Council, Fort St. George, dated India office, London, 23rd August 1888, No. 6, Public Works.

I have received your Excellency's Public Works letter No. $\frac{10}{1973\ W.}$, dated the 3rd July 1888, informing me of the resignation by Mr. F. N. Thorowgood of the post of Superintendent of the Madras Harbour Works, and the approval by your Government, on the recommendation of the Madras Harbour Trust Board, of the appointment, as a temporary measure, of Mr. A. L. Pogson, the present Assistant Superintendent, as Mr. Thorowgood's successor.

2. Your proceedings in this matter have my concurrence, but I am glad to learn that you have limited your sanction of Mr. Pogson's appointment "provisionally, pending settlement of the north-east entrance to the habour," as I am advised that it will be necessary, when active operations are resumed, to reconsider the matter in view to the appointment in question being filled by an officer possessed of more experience than Mr. Pogson has had opportunities of acquiring.

3. I desire, therefore, that I may be informed when the appointment in question is likely to be permanently made in order that the opinion of Mr. Parkes, the Consulting Engineer to this office for the works, may be obtained.

4. I am still awaiting the receipt of replies from your Government to my two Public Works despatches, Nos. 10 and 11, dated respectively 24th November and 15th December 1887, on the subject of future operations in connection with the Madras Harbour Works.

ORDER—dated 17th September 1888, No. 2913 W., Public Works.

Communicated to the Chairman, Harbour Trust Board, for information and guidance, with reference to G.O., No. 1804 W., dated 18th June 1888.

2. The despatches quoted in the last paragraph of the present communication have since been replied to by despatch No. $\frac{11}{3385\ W.}$, dated 1st August 1888.

(True Extract.)

(Signed) J. O. HASTED, Colonel, R.E.,
Secretary to Govt., P.W.D.

To the Chairman, Harbour Trust Board.
" Marine Department.

Exd. J. Henricus.
Spare Copies

GENERAL.
ESTABLISHMENT.

Govt. of | 1888 | Madras.

PUBLIC WORKS.

Dated September, 17th.

Read. Encl.

G.O., 17th Sept. 1888, No. 2913 W.

SEPTEMBER.

Madras Harbour Works

Despatch from the Secretary of State for India approving of the proceedings of the Government in accepting the resignation of Mr. Thorowgood and the tempotary appointment of Mr. Pogson; and inquiring whether the post is likely to be permanently made in view to the appointment of an experienced officer, communicated to the Chairman Harbour Trust Board.

GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

General.
Establishment.

READ—the following paper:—

From R. W. BARLOW, Esq., C.S, Chairman, Harbour Trust Board, to the Chief Secretary to Government, Marine Department, dated Madras, 20th October 1888, No. 2686.

Referring to G.O., No. 2913 W., dated 17th September 1888, Public Works, and paras. 2 and 3 of the Right Honorable the Secretary of State's despatch printed therein, I have the honor to report that the matter has been considered by the Trust at their meetings on the 5th and 12th instant, in connection with the plan for a north-east entrance, submitted with my No. 2685, dated 19th idem, and I now submit copy of a resolution passed by the Trust unanimously desiring that the Secretary of State may be addressed regarding the immediate confirmation of Mr. Pogson as Engineer of the Harbour Trust.

2. The only reason given for the suggested supersession of Mr. Pogson is that he (Secretary of State) "is advised" (by Mr. Parkes it is presumed) that it may be desirable to fill the post "by an officer possessed of more experience than Mr. Pogson has had opportunities of acquiring." An older and more experienced officer as regards engineering, generally, than Mr. Pogson, could of course easily be selected, but one possessing "more experience" of the particular kind, the Board require, for construction, it would be impossible to secure. Mr. Pogson has been six years connected with the works, is older than Mr. Thorowgood was when first appointed on Mr. Parkes' recommendation, and is intimately acquainted with all details of the old work, both above and below the surface, the latter being specially important, while his ability and grasp of the present situation are abundantly shown by the elaborate and exhaustive report he has prepared, and which is now before Government.

3. It should further be remembered that the officer selected will not merely be in charge of construction proper, but will be Engineer to the Trust, in charge of their numerous improvements, tramways, works, &c., on the pier and on shore between the two arms. Mr. Pogson is doing the work energetically and to the Trust's entire satisfaction, he works harmoniously with them, and with both the harbour and construction staffs, has the latter well in hand, and is popular with them, and talks the vernacular fluently, a great advantage when dealing with native workmen. No Engineer newly sent out from home would answer all these requirements so well, while he must be entirely without Mr. Pogson's local practical experience of the works. The Board think that no better selection than Mr. Pogson could be made, and I request that the Secretary of State may be addressed accordingly.

ENCLOSURE.

Extract of Proceedings of the Trustees of the Harbour of Madras, at a Meeting held at the Offices of the Board on Friday the 12th day of October 1888.

3. Read again G.O., No. 2913 W., Public Works, dated 17th September 1888, communicating despatch from the Right Honorable the Secretary of State approving the acceptance of Mr. Thorowgood's resignation and the provisional appointment of Mr. A. Lee Pogson as Engineer to the Harbour Trust Board.

Read minutes by Captain W. L. C. Baddeley, R.E., Messrs. C. E. P. VansAgnew, A. V. D. Best, Cowasjee Eduljee Panday, Captain H. A. Street, H.M.'s I.M., and the Chairman.

Resolved unanimously that the Board are of opinion that any change of Engineers at the present time would be most detrimental to the interest of the works, and further that Mr. Pogson is, both as regards ability and experience, the best selection that could be made, and that the Chairman address Government regarding his early confirmation as Engineer to the Board.

* * * *

(True Extract.)

(Signed) C. PINSENT,
Secretary, Harbour Trust Board.

Transferred to the Public Works Department.

(By order.)

(Signed) W. S. MEYER,
Ag. Assistant Secretary.

24th October 1888.

ORDER—dated 10th November 1888, No. 3573 W., Public Works.

Ordered that the Secretary of State for India be addressed.

(True Extract.)

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

To the Chairman, Harbour Trust Board.
" Marine Department.

Exd. J. Henricus.
Spare Copies

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Read minutes by Captain W. L. C. Baddeley, R.E., Messrs. C. E. P. VansAgnew, A. V. D. Best, Cowasjee Eduljee Panday, Captain H. A. Street, H.M.'s I.M., and the Chairman.

Resolved unanimously that the Board are of opinion that any change of Engineers at the present time would be most detrimental to the interest of the works, and further that Mr. Pogson is, both as regards ability and experience, the best selection that could be made, and that the Chairman address Government regarding his early confirmation as Engineer to the Board.

* * * *

(True Extract.)

(Signed) C. PINSENT,
Secretary, Harbour Trust Board.

Transferred to the Public Works Department.

(By order.)

24th October 1888. (Signed) W. S. MEYER,
Ag. Assistant Secretary.

ORDER—dated 10th November 1888, No. 3573 W., Public Works.

Ordered that the Secretary of State for India be addressed.

(True Extract.)

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

To the Chairman, Harbour Trust Board.
" Marine Department.

Exd. J. Henricus.
Spare Copies

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Read minutes by Captain W. L. G. Stubbsley, R.E., Messrs. C. E. P. Fanshawe, A. V. D. Rost, Cowasjee Eduljee Pestonjee, Captain H. A. Stuart, H.M.'s I.M., and the Chairman.

Resolved unanimously that the Board are of opinion that any change of Engineers at the present time would be most detrimental to the interest of the works, and further that Mr. Pigeon is, both as regards ability and experience, the best selection that could be made, and that the Chairman address Government regarding his early confirmation as Engineer to the Board.

* * * * *

(True Extract.)

(Signed) G. PIGGOTT,
Secretary, Harbour Trust Board.

Transferred to the Public Works Department.

(By order.)

(Signed) W. S. MEYER,
Ag. Assistant Secretary.

26th October 1888.

Orders—dated 10th November 1888, No. 3573 W., Public Works.

Ordered that the Secretary of State for India be addressed.

(True Extract.)

(Signed) H. B. MEAD, Colonel, R.E.,
Secy. to Govt., P.W.D.

To the Chairman, Harbour Trust Board
Marine Department.

Encl. 7. Heavisides.
Spare Copies

10

GENERAL.
ESTABLISHMENT.

Govt. of Madras. 1888

PUBLIC WORKS.

46

Dated November, 10th

Encl.

Read.

G.O., 10th Nov. 1888, No. 3573 W.

NOVEMBER.

Engineer of the Harbour Trust Board

Ordered that the Secretary of State for India be addressed regarding the appointment of the —.

21

GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

Buildings and Roads.
Civil Works.

READ—the following despatch from the Right Honorable Viscount CROSS, Her Majesty's Secretary of State for India, to His Excellency the Right Honorable the Governor in Council, Fort St. George, dated India Office, London, 15th December 1887, No. 11, Public Works:—

Madras Harbour Works. Remarks by Mr. Parkes on Report of Harbour Committee.

With reference to my Public Works letter No. 10, dated 24th ultimo, which forwarded, for your Excellency's information, copies of the report which has been presented by the committee appointed to consider the best position for the entrance to Madras Harbour, I now transmit copy of a letter which has been received from Mr. Parkes, the Consulting Engineer for the Harbour, containing his remarks on the conclusions of the committee.

2. Of the four designs which were laid before the committee by the late Captain Taylor, as representative of the Harbour Trust Board, the committee, for the reasons stated in their report, have recommended the adoption of No. III. Mr. Parkes, for engineering and other reasons, strongly urges the adoption of a design similar to No. I. The comparative merits of these designs are sufficiently discussed in Mr. Parkes' letter and in the minutes of evidence taken before the committee, of which copies are now forwarded for your Excellency's information.

3. Before coming to a final decision on the course which should be adopted on the recommendations of the committee, I desire to have the benefit of your Excellency's opinion in Council after obtaining the views of the Harbour Board on the whole subject.

ENCLOSURE.

From W. PARKES, Esq., to the Under Secretary of State for India, dated 23, Abingdon Street, 25th November 1887.

In compliance with the request contained in your letter of the 22nd instant, No. P.W. 2070, I have the honor to submit the following remarks on the report of the committee appointed to consider the above question.

2. It is desirable that I should at the outset explain my position with regard to this question. I have never taken a prominent part in its discussion. When it was originally raised in 1882, shortly after the destructive storm of November 1881, I recommended that a decision upon it should be deferred till the works of restoration had made some progress. When, in 1883, Sir John Hawkshaw's committee, in their first report, expressed an opinion unfavorable to the change of entrance, I ventured to recommend that this decision should not be accepted as final (see my report to the Government of Madras, dated 9th March 1882, paragraphs 44 and 45, and that to the India Office, dated 10th February 1883, paragraph 14).

3. The committee appointed by the Government of Madras, however, on the 30th April 1883, were not satisfied to leave the question in this state, but in their report, dated 20th June, forced an immediate decision by presenting an independent scheme of reconstruction, of which a north-east entrance was an essential feature. This scheme was referred to Sir John Hawkshaw's committee, and by them emphatically condemned. This decision was accepted as final by the Secretary of State, and I felt that the discussion of the question ought then to be considered as exhausted, and that my duty was to show how the admitted evils of the sanctioned eastern entrance could be best met by other arrangements. To this I devoted a large portion of my

report of 21st August 1884 (from paragraph 60 to the end), and to the further development of this I have since devoted much time and consideration.

4. It is right I should mention that while I disclaim any responsibility in this final decision in favor of the eastern entrance, I entirely acquiesced in it as the best under the circumstances, though had my opinion been officially asked I should have been disposed to say more about the views and arguments of the nautical men locally consulted than was said in the report of Sir John Hawkshaw's committee.

5. From the above it will be seen that there is nothing in my past attitude in regard to this question to prevent my acquiescence in the adoption of a north-east entrance, if such reason is shown for it as will place the decision on a logical basis, even though I might have to yield something of my own estimate of the balance of argument on a question on which there is admittedly much to be said on both sides; but I think it my duty, holding the position I do to give what assistance I can to enable the Secretary of State to decide whether an order based on the recommendations of the present committee can be considered as final and unassailable.

6. With this view I have given careful and critical examination to the evidence and to the committee's report, and I am bound to say that, in my opinion, the adoption of that report as a basis for further action will not relieve the undertaking of the difficulties under which it is at present laboring, but will rather tend to introduce new ones.

7. I do not propose to criticise the report in detail, but, in justification of the opinion above expressed, I would beg to direct attention to three points suggested by a study of the report:—

1*st*. The introduction of a question of far greater importance than that of the entrance, which, if solved in the direction indicated by the committee, would render the further discussion of the entrance question quite superfluous.

2*nd*. Its incompleteness as an authoritative basis for the action of Government.

3*rd*. A recommendation in a matter which, from the committee's point of view, is one of secondary importance, but from my point of view of primary importance, and to which, in my capacity of responsible Engineer of the works, I think it is within the scope of my authority to take exception.

8. The first question of importance above alluded to is set forth in the second paragraph in page 2 of the report. It is that—

"So rapid and regular is the encroachment of the sand on the south side, that, if continued at the same rate, which we have strong reason to apprehend will be the case, within 20 years the depth of water at the south-east corner will be reduced to four fathoms."

This apprehension is used as an argument against the formation of an entrance at the south-east corner, a proposal which has never been seriously entertained on account of the fact that the sand is advancing on that side of the harbour, but it is now for the first time introduced as it is in the committee's next paragraph as an argument against the eastern opening, though no reference is made to its causing any difficulty at the site of the north-east opening.

9. Now I submit that if this apprehension of the committee is to be taken as a ground for future action, it must be taken with all its necessary consequences. Those consequences are that within 20 years, that is, within the lifetime of the majority of the persons now employed in or about the harbour, the navigable depth of the south-east corner will be lost, that "at a time not very far distant" it will be lost at the middle of the sea face of the harbour, and by an inevitable continuance of the same process the site of the proposed north-east entrance will be subject to the same destructive action. Thus the present generation will witness the gradual absorption of the harbour in a mass of sand and the reduction of the advantages of Madras as a trading port to something far inferior to what they were before the harbour works were commenced.

10. It will be easily supposed that, when such a prospect as this was suggested to me, I lost no time in looking carefully to the grounds of my own very different conclusion. I am happy to say that the result has been the confirming and strengthening of that conclusion, and I think I may confidently add the detection of the fallacy on which the anticipation of the committee is based.

11. I would beg to explain in as few words as I can what is the conclusion which has been thus questioned. When my original proposal for a harbour at Madras was first put forward, objections were made to it in several influential quarters on the ground of its interference with the movement, and the consequent accumulation, of sand. This question was specially referred to Mr. Bateman, who was consulted by the Secretary of State before the scheme was sanctioned in 1875. Mr. Bateman's opinion was that the injurious accumulation of sand would take so long that it might be disregarded.

12. The first year's work caused what appeared to be a formidable accumulation, and the question was again raised and fully discussed, with the result that the Government was reassured. A calculation was made showing that the accumulation in one south-west monsoon occupied about one-fiftieth of the space available for arresting the sand, thus giving 50 years as the minimum

life of the harbour, without making any allowance for the opposite movement in the north-east monsoon, which was known to be considerable, but which could not then be definitely determined. Fifty years, therefore, with a considerable, but not at that time accurately determinable, addition was taken as approximately the time during which no measures need be taken to protect the harbour from sand.

13. Even after this the question was from time to time raised and discussed, but one objector after another dropped off, and since 1879 the question has been absolutely at rest.

14. In the meantime the movements of sand have been carefully watched, recorded, and reported on, so that if any one were disposed to object, the data were always at hand on which to base any adverse theory. But no one has come forward, and, on the contrary, the accumulation of facts has been such as to confirm in the most complete manner the correctness of our original anticipations. Each year shows a slight advance of beach, and the advance from year to year is so regular, though proceeding at a decreasing rate, as to show that the accretion is not the result of casual and variable storms, but of some regularly recurring seasonal action. The oblique stroke of the light but continuous surf on the beach is generally acknowledged as a sufficient cause for the results seen and recorded.

15. A position thus built up by the confirmatory experience of 10 years has a strong presumption in its favor. It may be based on a fallacy, but I submit it deserves to be attacked, if it is to be attacked at all, by some well-defined alternative theory. For such I have been looking anxiously since I first heard the committee were not satisfied with my position, but all I have got as a result is the vague statement of their apprehensions quoted in paragraph 8.

16. This statement is based on certain figures from which the committee and myself draw very different conclusions. In May 1886 there was a heavy cyclone sea which produced certain exceptional results, the shore line was considerably washed back, and there was a considerable accretion of sand at two, three, and four fathoms under water.

17. The committee examining the latter alone came to the conclusion that it did not bear out my contention that the advance proceeds in a decreasing annual ratio, but the contrary, and they show that if it continues at the same rate in future as in the last four years, the four-fathom line will reach the south-east corner of the harbour in 15½ years. This period is increased in their report to 20 years, though upon what grounds does not appear.

18. My deduction from the same data, but including with them the upper parts of the slope which were washed back, is that the rate of advance is decreasing, and that the measurements as a whole show that the disturbance of the storm of May did not result in any addition to the normal year's accumulation, but simply redistributed it by drawing down sand from the shore. Thus, my original calculation of 50 years as the *minimum* estimate of the life of the harbour is in no way affected, but the measurements show that the originally indeterminable addition to the 50 years may be taken to be at least 10 years, so that there is half a century to run from the present time. I think it unnecessary at present to cite further figures, but I may say that, if a further investigation were required, these would be forthcoming, and would confirm in a remarkable way my general conclusion.

19. I should add that the difference between the committee and myself is not limited to the question of 20 or 50 years. There is another point of almost equal importance. I contend that it is now well established how the sand comes, and in what quantities it comes, and therefore how it may be intercepted when it becomes necessary, and what the cost of intercepting it will be. It may be added that that cost, which will not be required for 50 years, will not thenceforward be a serious burden on the trade. On the committee's supposition there is no such knowledge. If the sand is conveyed by currents (which, though not suggested by the committee, is the only other conceivable vehicle for its transport) it is impossible to say how or where it will be deposited, or whether it can be in any way controlled.

20. I have now shown how very different are the conclusions drawn by the committee and myself from the same data. I hope I have also shown to the satisfaction of the Government that my conclusions are not of a character to be set aside in favor of such a vague suggestion as that put forward by the committee. But if the case ended here I should hardly feel justified in asking that the committee's suggestion should be set aside in favor of my conclusion. I could only ask that a decision should be postponed pending a reference to further experience. Meanwhile a continuance of the present heavy rate of expenditure on the works would be hardly justifiable.

21. But since the committee ceased their sittings, after the members had left town, and while the report was in circulation for signature, information has reached me which I think has brought the question to a practical test. A survey was made in September 1887 which shows the exact position of the four-fathom contour at that date. It will be remembered that the committee's apprehension was that this would continue to advance at the same rate as in the four years previous to 1886. I contended that the advance in 1886 was exceptional and raised the average abnormally. I expressed my belief that future years would show, not a retreat, but a retarded rate of advance till the average normal annual rate was restored.

22. The following are the facts shown by the recent survey. On the line of section 300 feet south of the pier the average annual advance between 1882 and 1886, and which the committee expected to continue, was 120 feet. From 1886 to 1887 the actual advance was, however, 10 feet.

On the line of section 550 feet south of the pier the anticipated advance was 90 feet, the actual 35 feet.

At 950 from the pier the anticipated advance was 78 feet, the actual 30 feet.

At 1,350 from the pier the anticipated advance was 65 feet, the actual 70 feet.

The fifth section was not repeated, but this as well as the fourth, and to some extent the third, had shown in 1886 much less exceptional disturbance than those nearer the pier.

23. Now, in view of these facts, I think I may go a step further than I should have ventured to do before the receipt of this information, and ask that this suggestion of the committee should be dismissed as a groundless scare.

24. I now proceed to the second point named in paragraph 7, viz., "The incompleteness of the committee's decision as an authoritative basis for the action of Government." On this point I need hardly explain that I do not claim to have any voice except as contributing information necessary to enable the Secretary of State to form a decision.

25. I would remark that there is this peculiarity in the subject referred to the committee. An authoritative decision upon it, fully endorsed by the Secretary of State, is already in existence. Since that decision was given, 3½ years ago, there has not arisen any new evidence on matters of fact, nor has any new question been introduced except that of the advance of the sand, which has been introduced by the committee themselves, and not by any of the witnesses on one side or the other. This question, as I have shown, is of far greater importance than the question of entrance. It must be dealt with independently of the latter, and in one of the three following ways, each of which will suggest its own consequences. If the committee's view of the sand question is to be accepted as proved, I can see no other course than to at once abandon, and close the accounts of, a most unfortunate and ill-advised undertaking. If the question is to be reserved for the test of further experience, further outlay should be suspended till time has solved it. If it be at once and finally rejected, as I think I have shown may be safely done, then the effects of its removal from the committee's balance of argument must be considered.

26. Taking the last alternative, it is to be observed that the point is introduced by the committee simply as an argument in favor of the north-east entrance. But there is nothing to show what weight they give to this argument, and whether its removal will transfer the balance to the other side. If it did so, of course, the decision as now pronounced would be null and void. If it did not, then we should have two co-existent but conflicting judgments, based upon the same evidence, one pronounced by Sir John Hawkshaw, Sir John Coode, and Professor Stokes, the other by Admiral Salmon, Sir John Coode, and Sir George Nares.

27. This somewhat peculiar position derives importance from a fact which has been brought to light by this inquiry. I have said that the evidence as to matters of *fact* was identical before the two committees. In the evidence as to matters of *opinion* there is a marked contrast between the two. In the earlier case the nautical evidence was represented to be unanimous in favor of the north-east entrance. This alleged unanimity no doubt had great weight as an argument with the Harbour Trust Board, with the Government of Madras, and with the Government of India, but it is an argument which no longer exists. The unanimity has completely broken up, and it is now shown that nautical opinion is very much divided on the subject.

28. Under these circumstances, is it certain that the present strong feeling in favor of the north-east entrance will be permanent at Madras? The immediate or proximate successor of the late Captain Taylor may be an advocate of the eastern entrance. The Harbour Trust Board is a changing body. The financial view of the question, as yet hardly presented, will open a prospect of an addition of 40 or 50 per cent. to the harbour dues. May not these considerations, and I can imagine others to support them, give rise to an urgent demand for an appeal from Admiral Salmon's committee, which would be supported by the precedent of the appeal granted from Sir John Hawkshaw's committee?

29. I now pass to the third point named in paragraph 7, as to "a recommendation in a matter which from the committee's point of view is one of secondary importance, but from my point of view may be of primary importance, and to which, in my capacity of responsible Engineer of the works, I think it is within the scope of my authority to take exception." I fear it will be considered that what I have already said has rather enhanced than otherwise the difficulties of the situation. I hope that what I have now to say may do something to suggest a solution, though unfortunately I have to begin by again joining issue with the committee.

A № 4
B № 3

30. When I was before the committee on the 29th June, several schemes for a north-east entrance were shown to me, and my opinion upon them was asked. I was informed that the choice was virtually limited to two, which I will call A and B. Having previously seen and considered these I was able to speak definitely, and I gave the preference, for reasons adduced, very decidedly to plan A. There was much general discussion of the matter, and I left the room with the strong impression that the members of the committee were equally in favor of plan A.

31. Several weeks afterwards I was requested to furnish estimates of these two schemes, and finding that my anticipation that the cost of plan B would be considerably greater than that of plan A was fully confirmed, the difference being nearly 5 lakhs of rupees, and remembering the impression made upon me that the committee were fully alive to the other objections to plan B, which had been fully discussed, I did not think it necessary to repeat these in writing, and furnished simply the estimates in abstract.

32. It was therefore with considerable surprise that I afterwards found that the committee had adopted plan B, with all its objections, as their final recommendation, and make no allusion in their report to plan A. My objections to plan B are, of course, mainly on engineering grounds, and these might be outweighed by any considerable superiority on nautical grounds, but it is a case in which it is impossible that such considerable superiority can exist. I cannot admit that even the engineering member of the committee can be so good a judge as myself of the relative difficulties of carrying out the two schemes, and I submit that it is a matter of detail in which the committee's recommendation may be amended so as to make it conform to my views. I do not now trouble you with the details of my objections, but I shall be ready to furnish them if required.

33. What I have now to say is dependent upon the substitution of plan A for plan B. The estimated cost of plan A (in addition to the sanctioned estimate) is Rs. 18,11,411, with an overlap of 600 feet, or of Rs. 20,86,677, with an overlap of 800 feet. This is supposing that its adoption is decided on before the work proceeds any further. I find that if the work were allowed to proceed upon the sanctioned plan till each pier is built to within about 300 feet of its termination, and the formation of a north-east entrance according to plan A were then ordered, the ultimate extra cost would be something under a half a lakh of rupees, say 18½ lakhs or 21¼ lakhs.

34. If this were done the harbour would be virtually restored to the state in which it was previous to the storm of November 1881, for the last 300 feet of each pier are standing in a state to give effectual shelter, and the question of a change of entrance might then be reconsidered in view of the actual effect of the piers as originally designed. The trade would then have the benefit, such as it is, of such a harbour in a virtually complet state pending the construction of the new entrance. To carry out the work to that extent would take about eighteen months, during every month of which time the shelter would be improving. To proceed on the plan recommended by the committee, the first two or three years would be spent in opening the harbour still more to the sea, and that in the most dangerous possible form, while a further three years would be occupied before anything like efficient shelter would be obtained.

35. In conclusion, I would beg to call attention to one point which has not been mentioned by the committee. The committee have stated very fairly how various admitted evils would be cured by the construction of the north-east entrance. For these evils Captain Taylor and others only allow the possibility of one remedy. It should be borne in mind, however, that many of them can be cured by other and less costly remedies, as I have previously shown. Credit should be taken for these on the side of the eastern entrance without necessarily assuming that they will place the whole balance of advantages in its favor.

Order—dated 16th January 1888, No. 153 W., Public Works.

Communicated, in continuation of G.O., No. 3484 W., dated 20th December 1887, to the Chairman for an expression of opinion by the Harbour Trust Board.

(True Extract.)

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

To the Chairman, Harbour Trust Board, with one plan and copy of report.
" Marine Department.

Exd. J. Moses.
Spare Copies

BUILDINGS AND ROADS.
CIVIL WORKS.

Govt. of {1888} Madras.

PUBLIC WORKS.

Dated January, 16th.

Recd. *Encl.*

G.O., 16th Jan. 1888, No. 153 W.

JANUARY.

Madras Harbour Entrance

Communicating to the Chairman, for an expression of opinion by the Harbour Trust Board, despatch from the Secretary of State forwarding a letter from Mr. Parkes containing his remarks on the conclusions of the London Committee on the question of the —.

MINUTES OF EVIDENCE

TAKEN BEFORE

THE COMMITTEE

APPOINTED BY THE SECRETARY OF STATE FOR INDIA IN APRIL 1887 TO CONSIDER THE QUESTION OF THE

POSITION OF THE ENTRANCE

TO

MADRAS HARBOUR.

LONDON:
PRINTED BY EYRE AND SPOTTISWOODE,
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1888.

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Opinions that the greater facilities are afforded by an eastern entrance, *Parkes*, 247, *Hector*, 375–76, 379–80, 403; *Alderton*, 450–58, 517–19, 532–34; *Henderson*, 582–86, 634–45; *Latil*, 2294–95, 2350–54, 2371–72, 2701–86; *Murray*, 2413, 2438–43, 2482–86, *Adamson*, 2513–19, 2531–45, (with reference to difficulties from currents in entering or leaving by a north-east or eastern entrance, *See* also under "Currents"); danger to a vessel entering by north-east entrance, (plan III.) by being driven against breakwater by westerly winds, *Taylor*, 1592–94; comparative advantages of the two entrances with regard to towing and sailing ships, *Taylor*, 1674–75, 1684–88; *Horne*, 1941–42.

(ii.) With regard to the quietude of the harbour and commercial facilities. Opinions in favour of a north-east entrance, *Barlow*, 923–28, 972–74; *Sankey*, 1025–35, 1112, 1133–46, 1162–63; *Shaw-Stewart*, 1193–95; *Taylor*, 1351–73, 1381, 1418–26, 1625–28; *Horne*, 1899–1907; *Latil*, 2294–97; *Murray*, 2417–20, 2459–67; *Chambre*, 2659–61; *Turner*, 3260–62; *Underdown*, 3475–65; opinions in favour of retaining the eastern entrance, *Adamson*, 2516–19; *Thorowgood*, 2559–61, and of providing additional facilities for landing goods, and of excavating a boat harbour, *Parkes*, 3013–29; the extra tranquility gained by closing the eastern entrance would not justify a very heavy outlay, *Barlow*, 950, 979. (With regard to the effect of closing the eastern entrance in making the harbour a secure port of refuge in cyclones see under "Refuge.")

(iii.) With regard to space in the harbour and anchorage. Opinions in favour of a north-east entrance. *Barlow*, 945–49; *Shaw-Stewart*, 1218–19; *Taylor*, 1333–35, 1676–83, 1734; *Horne*, 2018–45; *Taylor*, 2206–16. Number of vessels that can be accommodated in harbour with present entrances. *Henderson*, 650; *Taylor*, 1680, 2206. Number of ships that could be accommodated if the north-east entrance were adopted. *Taylor*, 2215.

(iv.) With regard to the sanitary condition of the harbour. *Horne*, 2060–61; *Taylor*, 2144–51.

(v.) With regard to the advance of sand from the south. *Parkes*, 166; *Sankey*, 1108; *Taylor*, 2163–64, 2186, 3118–24; *Parkes*, 3658.

Different designs for a north-east entrance:

Modification proposed by Mr. Parkes in the plan proposed by the Madras Committee. *Parkes*, 310.

Four designs considered by the Harbour Trust Board, numbered I., II., III., IV. *Taylor*, 1464.

Comparative merits of plans I. and II. from a nautical point of view. *Parkes*, 3004–6. Comparative merits of designs I. and III., from an engineering point of view. *Taylor*, 1374–75; *Parkes*, 2994–3003; *Lowe*, 3157–72; *Thorowgood*, 3513–29. Comparative merits of designs I. and III., with regard to admitting sea and currents. *Underdown*, 3362–63. Objections to No. IV. plan. *Taylor*, 1712–19; *Parkes*, 3007. Comparison of plans III. and IV. with regard to space available for moorings. *Taylor*, 1726–32. Comparative merits with regard to ingress of plan III., and an entrance 500 feet nearer shore; *Turner*, 3335–45.

Opinions regarding the length desirable for the protecting arm for a north-east entrance. *Parkes*, 311, 332–5; *Horne*, 1909–12; *Taylor*, 2203–5; *Hire*, 2265–68; *Latil*, 2341–3; *Murray*, 2444–50; *Fanshawe*, 2595; *Chambre*, 2667–68, 2688; *Underdown*, 3456–58. Objections to the curve in the protecting arm in the plan originally proposed by the Madras Committee. *Parkes*, 699–710; *Sankey*, 1104–7. Opinions as to the bearing which the end of the projecting arm should have to the end of the north pier in order to keep the sea out. *Taylor*, 1652–4, 2143; *Horne*, 2078–82.

Width of entrance necessary for a north-east entrance. *Horne*, 1930, 1983–87, 2097; *Taylor*, 2174–76; *Murray*, 2455; *Fanshawe*, 2638; *Turner*, 3277–79.

Question whether the projecting arm in plan III. would catch the westerly current along the northern arm of the harbour and cause deposit

of sand. *Horne*, 1913–17, 2703; *Taylor*, 2123–39; *Parkes*, 2795–800; *Lowe*, 3144–45; *Thorowgood*, 3523–25.

Difficulties in removing the blocks and rubble base from the site of a north-east entrance, and time required. *Lowe*, 755–816, 3164–69; *Underdown*, 3370–3432; *Thorowgood*, 3517–29, 3575–92.

Two methods of proceeding proposed in constructing a north-east entrance:

(i.) To build over the site of the proposed entrance and complete the harbour on the original design, and subsequently clear the entrance on the completion of the projecting arm. (Plan I.) *Parkes*, 263–297, 314–331, 699–98; *Sankey*, 1147–57, 1170–77; *Shaw-Stewart*, 1270–73, 1278–82; *Lowe*, 3137–72; *Underdown*, 3380–3439; *Thorowgood*, 3517–20; (Plan III.) *Lowe*, 3157–72, *Underdown*, 3406–08.

(ii.) To commence clearing the north-east entrance at once, and complete the sea face of the harbour from the south. (Plan I.) *Parkes*, 714–20; (Plan III.) *Taylor*, 1457–58, 1465–96; *Horne*, 2053–55; *Thorowgood*, 3520, 3575–92.

Comparative expenses of the two methods above referred to, supposing Plan I. for a north-east entrance to be adopted, *Parkes*, 318, 322–23.

In opening a north-east entrace the removal of the rubble base would be more difficult than removing the blocks. *Parkes*, 279; *Sankey*, 1149.

The site of the proposed entrance in Plan I. has already been built upon to the extent of two-thirds of the whole distance. *Parkes*, 287–88.

Cost of constructing a north-east entrance, and estimate of time required. *See* under "Estimates."

EROSION of beach north of the harbour. *See* under "Sand."

ESTIMATES:

Estimate of cost of constructing a north-east entrance on plan suggested by the Madras Committee in 1883 (Plan I). *Parkes*, 302–6, 687–89.

Estimate of time required for clearing the site of a north-east entrance under Plan I. *Parkes*, 687; *Lowe*, 800, *Taylor*, 1471. Estimate of time required for completing the harbour under plan I. *Parkes*, 711–5; *Thorowgood*, 3532–7, 3597–8.

Estimates of cost prepared by Mr. Thorowgood of the four designs for a north-east entrance considered by the Harbour Trust Board in 1887. *Taylor*, 1464, 1642–50; *Thorowgood*, 3515–16, 3530–31, 3572–74, 3593–96.

Estimate of time required for completing the harbour with a north-east entrance according to plan III. *Parkes*, 2995–96; *Thorowgood*, 3599.

Expense of constructing a north-east entrance compared with cost of a boat harbour, screw pile pier, and ship dock in south-west corner of harbour. *Parkes*, 252–62, 3013.

EXTENSIONS: Future extensions of the harbour. *Parkes*, 167; *Taylor*, 1459, 1539–42.

GROUND SWELL: Strength and duration of the easterly ground swell. *Lowe*, 848–52, 862–73; *Barlow*, 924; *Taylor*, 1373, 1381.

GROYNES:

Efficacy of groynes in arresting the sand movement from the south. *Sankey*, 1083–84, 1098–1103; *Taylor*, 1572–91; *Parkes*, 2912–29; *Thorowgood*, 3634–44; *Parkes*, 3687–92.

Groynes north of the harbour. *Horne*, 2745–47; *Parkes*, 2904; *Thorowgood*, 3634–35.

Sir Arthur Cotton's breakwater, *Parkes*, 2974–78.

HARBOUR:

Relative insufficiency of length of Madras harbour. *Sankey*, 992; *Parkes*, 2992.

As to adequacy of harbour walls (as now being constructed) to resist cyclones. *Henderson*, 661; *Sankey*, 1021–22; *Horne*, 2049; *Taylor*, 2195–2202; *Parkes*, 2850.

Utility of harbour at present. Opinions that the harbour affords considerable shelter. *Alderton*, 449; *Murray*, 2404, 2408; opinions that no appreciable benefit is derived from the harbour. *Barlow*, 919; *Hire*, 2242; *Taylor*, 1362–67;

1376–77; *Latil*, 2327–8; *Adamson*, 2529–30; *Turner*, 3280–84; *Fanshawe*, 2619.

Capacity of the harbour. *Henderson*, 650; *Taylor*, 1680, 2206, 2215.

INSURANCE: Question of insurance in case of a ship being wrecked inside Madras harbour in a cyclone. *Alderton*, 549–52.

JETTIES: Jetties commenced before destruction of harbour in 1881. *Parkes*, 85; *Taylor*, 1358.

KINGSTOWN HARBOUR compared with Madras. *Sankey*, 1037, 1181; *Parkes*, 2992.

LIGHTS: Want of, at the harbour entrance. *Hector*, 411, 423.

MASOOLAH BOATS require beaching; could be dispensed with in a quiet harbour. *Taylor*, 1626–27.

MOORINGS: Want of, in the harbour. *Alderton*, 496–99; *Henderson*, 681–85. Original scheme of moorings in the harbour. *Sankey*, 1113–14; *Taylor*, 1706–12; *Horne*, 2012; *Parkes*, 2850 (last para).

PILOTAGE is obligatory at Madras. *Murray*, 2399; *Fanshawe*, 2575; *Taylor*, 3126.

PORT RULES with regard to warnings of threatened cyclones. *Parkes*, 184; *Alderton*, 441; *Taylor*, 1431, 2128; *Horne*, 1820.

PORT TRUST:

Position of the Port Trust with regard to the harbour. *Taylor*, 1298–1319.

Proceedings of the Port Trust. Description and comparison of the four designs for a north-east entrance considered by them. *Taylor*, 1464.

REFUGE:

Opinions as to Madras harbour considered as a harbour of refuge.

(i.) With present eastern entrance the harbour could not be regarded as a harbour of refuge. *Parkes*, 183, 201; *Hector*, 378, 415; *Alderton*, 445, 546; *Henderson*, 657; *Barlow*, 920–1; *Sankey*, 1125; *Taylor*, 1430.

(ii.) With a north-east entrance. Opinions that the harbour could become a harbour of refuge. *Sankey*, 1075–8, 1112, 1146; *Shaw-Stewart*, 1201–3, 1266–9; *Horne*, 2046, 2777–82; *Turner*, 3323–8. Opinions that the harbour could not become a harbour of refuge. *Hector*, 379, 415; *Alderton*, 548; *Barlow*, 922; *Taylor*, 1431–4; *Latil*, 2292, 2321–3; *Murray*, 2419–20; *Fanshawe*, 2607; *Underdown*, 3460–4.

(iii.) With regard to protection for small craft, dredgers, &c., during a cyclone. *Taylor*, 1439; *Latil*, 2361–63; *Adamson*, 2548–49; *Lowe*, 3244; *Turner*, 3328; *Thorowgood*, 3560–61.

The original intention in constructing Madras harbour was to provide a harbour of refuge. *Sankey*, 1118–9; *Taylor*, 1602.

REVETMENTS:

De Haviland's bulwark. *Taylor*, 1632; *Parkes*, 2971.

Revetments of the beach north of the harbour. *Parkes*, 2790–94, 2819–20.

RUBBLE:

Nature of the rubble used for the base of the harbour walls. *Taylor*, 1510–20.

Undermining of the rubble base by currents. *Taylor*, 1510, 2135; *Parkes*, 2801–7.

RUINS:

Of the harbour, present state of. *Parkes*, 221–37; *Henderson*, 616–8.

Disposition of the fallen blocks. *Parkes*, 238.

A vessel washed over the ruined breakwater. *Alderton*, 503–9.

Effect of the ruins in affording shelter from the sea. *Lowe*, 875; *Horne*, 1828.

Subsidence of the ruined work. *Taylor*, 1497–1510; *Parkes*, 2850, 2978–80.

SAND:

Movements of sand during construction of works. *Parkes*, 134–7, 2958 (paras. 18–24 of paper on sand movements).

Movements of sand within harbour. Opinions that the high water-line is not advancing and that there is no material decrease in depth. *Parkes*, 138–9; *Sankey*, 1026–37; *Horne*, 1744–48, 2068; *Murray*, 2428–30; *Parkes*, 2844–49.

Opinions that the shore line is advancing. *Taylor*, 1618–25, 2130; *Latil*, 2308–10, 2316.

Rate of seaward advance of sand south of harbour. *Parkes*, 139–162; *Henderson*, 652; *Sankey*, 1081–83; *Shaw-Stewart*, 1206, 1250; *Taylor*, 1382–5, 1446–56; *Murray*, 2427; *Parkes*, 2830–43, 2851–2911; *Taylor*, 3108–17; *Thorowgood*, 3470–3503; *Parkes*, 3645–3730.

The advance of the beach caused by the harbour, begins about 2 miles south of Madras. *Parkes*, 150; *Shaw-Stewart*, 1274.

Period within which the advance of sand would affect navigation in a line with the eastern entrance. *Parkes*, 164; *Sankey*, 1083; *Parkes*, 2830, 2883, 3646–3649.

Tabular statement prepared by the Committee from soundings showing the annual seaward advance of the sand south of the harbour. 2843.

Statement prepared by Mr. Parkes on the same subject. *Parkes*, 2859.

Shoaling at south-east knuckle of the harbour. *Parkes*, 144, 154, 161; *Sankey*, 1082–83; *Taylor*, 1385, 1418–17, 1567, 2165–70; *Parkes*, 2969 (paras. 25–28 of paper on sand movements); *Thorowgood*, 3476, 3486, 3488–3503.

Sand in suspension brought by currents from the south. *Parkes*, 213; *Taylor*, 1388–98, 1543–71; *Horne*, 1988–2006, 2752–61; *Parkes*, 3071.

Erosion of beach on north side of harbour. *Latil*, 2310; *Horne*, 2704–11; *Parkes*, 2788–94, 2970 (paras. 30–32 of paper on sand movements).

The erosion of the beach is due to wave action, not currents. *Horne*, 2705–6; *Parkes*, 2823; opinion that the sand from the north side of the harbour has been carried by the current to the south-east. *Horne*, 2698–718; *Lowe*, 3140–6, 3203–9; opinion that the sand from the north of the harbour is carried to the northward by currents. *Taylor*, 3030–61, 3090–3; not much erosion immediately north of the harbour. *Parkes*, 2820.

Efficacy of groynes in arresting the sand movements. *Sankey*, 1083–84; 1098–1103; *Taylor*, 1572–91, *Parkes*, 2912–29; *Thorowgood*, 3634–44; *Parkes*, 3687–92.

Process of formation of sand banks along the Madras coast. *Taylor*, 1397, 1406–11, 1559–60, 2189–91.

Character of the sand on the Madras coast. *Taylor*, 1618; *Parkes*, 2982–86.

Sand carried into the harbour by wind and through crevices in the work. *Horne*, 1748; *Taylor*, 2152–62; *Latil*, 2317; *Parkes*, 2844–49; *Underdown*, 3445.

Movements of sand north of the harbour. *Horne*, 2698–2711, 2732–61; *Parkes*, 2819–23, 2897–2908, *Taylor*, 3050–78; *Lowe*, 3140–56, 3203–37.

Difference in the movements of sand under the influence of currents during the two monsoons, *Horne*, 2732–61; *Taylor*, 3038, 3045–48; *Thorowgood*, 3600–13; *Lowe*, 3219.

Question whether the sand accumulation to south of harbour is entirely due to the normal alongshore movement of the sand or partly owing to sand brought by current from the south. *Parkes*, 2863, 2875, 2894–96, 3656, 3671–75, 3704–16.

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Paper entitled "Notes on the movements of sand in and near the harbour" read by Mr. Parkes to the Committee. *Parkes*, 2930–70.

Comparative movement of sand from the north and south respectively. *Sankey*, 1060; *Parkes*, 2908, 2946 (para. 17 of paper on sand movements)–50; *Taylor*, 3045–48.

Different effect on the movement of sand of light and heavy seas. *Parkes*, 3649–51.

Abnormal effect on the beach south of the harbour of the cyclone in May 1886. *Parkes*, 3653.

SANITARY conditions and prospects of the harbour. *Horne*, 2056–61; *Taylor*, 2144–50.

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The heavy seas at Madras are generally due to distant cyclones. *Parkes*, 50; *Henderson*, 581; *Taylor* 1373.

SEA—*continued.*

Distinction between the regular easterly swell and the swell or sea due to the prevailing wind. *Parkes*, 57; *Alderton*, 439; *Henderson*, 631; *Barloe*, 907–08; *Shaw-Stewart*, 1190.
Longer continuance of southerly seas, but northerly seas stronger. *Parkes*, 53, 74, 79.
Distance from shore of break of sea. *Parkes*, 60–66; *Alderton*, 479, *Henderson*, 641; *Taylor*, 1689–95; *Horse*, 1829–37, 1846–51; *Taylor*, 2178–80.
State of the sea inside the harbour as at present compared with the sea outside. *Parkes*, 69–71; *Alderloe*, 449, 483, 495; *Henderson*, 591–5; *Barloe*, 1372; *Hire*, 2242, 2252–53; *Latil*, 2347; *Murray*, 2404, *Turner*, 3254–58, 3280–82.
State of the sea inside the harbour before it was wrecked by the cyclone of 1881. *Parkes*, 92–103; *Alderton*, 511; *Lewis*, 895–45; *Sankey*, 992–7; *Shaw-Stewart*, 1191, 1256; *Taylor*, 1353; *Horse*, 1902, 1952–53; *Latil*, 2290–91, 2319; *Murray*, 2404, 2408; *Adamson*, 2504–9.
Break of the sea over the harbour walls. *Parkes*, 51,205; *Hector*, 368, 373; *Alderton*, 493, 502, 541; *Henderson*, 620–1; *Barloe*, 981–3. Break of the sea over the walls during the cyclone of November 1881; *Sankey*, 1017–18, 1021–22; *Shaw-Stewart*, 1196; *Taylor*, 1359, 1378–81.
Question whether the rough sea inside the harbour is due to the relative insufficiency in length of the harbour. *Sankey*, 992; *Parkes*, 2992.
Description of the sea inside the harbour during cyclone of November 1881. *Sankey*, 1048–56; *Shaw-Stewart*, 1255; *Taylor*, 1378–81; *Horse*, 1954–72; *Thorogood*, 3504–09.
Reflection of the waves inside the harbour during cyclone of 1881. *Sankey*, 1048–56, 1062–67, 1071–74; *Taylor*, 2222–26.
Conditions of sea at Madras in ordinary weather. *Horse*, 1943–53.
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Effect of sewage in silting up the harbour. *Taylor*, 1621, 1634–41, 2148–51.
Outfall of the sewers north and south of the harbour; discoloration of the sea. *Parkes*, 2810–18; *Taylor*, 3079–89.

SHIPPING:
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If a north-east entrance were substituted for the present eastern entrance, sailing vessels could use the harbour. *Sankey*, 1129; *Taylor*, 1684.
Proportion of trade carried by sailing vessels as compared with steamers is very small. *Parkes*, 198; *Henderson*, 605–10; *Taylor*, 1367, 1684.
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Mr. Parkes' proposals for increasing the facilities for landing and shipping goods in the harbour. *Parkes*, 3015–14.
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WINDS:
Prevailing direction, and mean velocity. *Parkes*, 7–54; *Hector*, 391.
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South-easterly gales very rare. *Parkes*, 46; *Taylor*, 1451.

MINUTES OF EVIDENCE

TAKEN BEFORE

THE COMMITTEE

APPOINTED TO INQUIRE INTO THE QUESTION OF THE

POSITION OF THE ENTRANCE TO THE MADRAS HARBOUR.

At the Board of Trade, Whitehall.

Tuesday, 26th April 1887.

MEMBERS PRESENT:

VICE-ADMIRAL SIR NOWELL SALMON, V.C., K.C.B., IN THE CHAIR.

SIR JOHN COODE, K.C.M.G. | REAR-ADMIRAL SIR GEORGE S. NARES, K.C.B.

MR. F. C. THOMPSON [India Office], *Secretary.*

Mr. WILLIAM PARKES, M. Inst. C.E., examined.

Mr. W. Parkes, M. Inst. C.E.

26 April 1887

1. (*Chairman.*) I think, if you will allow me, I will read to you an extract from the letter which forms the basis of our inquiry. Speaking of the decision of the Committees that sat in England upon the subject of Madras Harbour Works, the Secretary of State for India says:—"The decision arrived at has, however, "failed to give entire satisfaction in India, and grave "doubts are entertained by some persons whether a "permanent mistake will not be made if the plan "then approved is carried out. Viscount Cross is "most anxious to avoid any such error, and to remove "all doubts. He has accordingly given instructions "that the work in connexion with the entrance shall "be suspended, and the Committee now appointed is "requested to examine the subject thoroughly, and, "with the aid of such nautical and other evidence and "opinions as they may think fit to obtain, to advise "him where the entrance should be placed, so as to "provide in the greatest degree for the safety and "convenience of ships using the harbour." Having read you that, I must first ask you what is your position with regard to the Madras Harbour Works?—I have been from the commencement the engineer-in-chief of the Madras Harbour Works, but within the last few months the works have been placed in the hands of the Port Trust, and in consequence of that my position has been altered to that of consulting engineer to the Secretary of State for the Madras Harbour.

2. I think you are practically responsible for the Madras Harbour as it was at the time it was destroyed by the cyclone in November 1881, are you not?—Yes.

3. Of course you had been some considerable time on the spot, and had made a thorough study of all the local circumstances likely to affect such a construction, had you not?—Yes.

4. Can you put in anything for the information of the Committee, giving the direction and force of the winds throughout any given year?—I am not quite sure whether I can give it in any given year, but I can give the results of many years' observations at the Madras Observatory.

5. (*Sir John Coode.*) Have they an instrument sufficient to measure the force of the cyclones?—They have an instrument at Madras Observatory, but I do not put any great stress upon their measurement of the force of the cyclones.

6. How did the instrument behave; did it seem to indicate anything like gradually increasing force?—Yes, it does that. It professes to give the velocity in miles per hour, but there is some doubt thrown upon it by recent observations. The velocity given by the instrument is considerably less than what experienced observers would put it down to be. On the occasion of a cyclone last November, I must refer to my memoranda to see exactly what it was the instrument gave.

7. (*Chairman.*) I think we will come to that afterwards. At present we will confine ourselves to the general question?—I will just hand to you two documents. *This* one gives the results of six years from 1870 to 1875. The anaual prevailing direction of the wind is from south-east by south, and the mean daily velocity, disregarding direction, 175 miles. The resultant direction for the whole year is south-south-east, and the resultant daily velocity is only 30 miles.

8. I think, as regards that, we have heard that statistics are always misleading. I think we must please divide the year into two parts, the north-east and the south-west monsoon?—This second paper, I think, will give that. This, it appears, has been compiled for a report upon the drainage of Madras, by Mr. Jones, engineer of the municipality. I think it only refers to the directions of the wind. It gives the number of days on which it blows from any given direction.

9. That would be of use to us?—It shows very clearly the difference in the monsoons.

10. That is what we want to get in the first place. *This* plan would show that for about two-thirds of the year the direction of the wind ranges from south-south-east to west by south, would it not?—Yes.

11. With the greatest proportion from south-south-east to south-west; the other third of the year the wind ranges from north to east-north-east; the largest proportion of the general direction being north-east by north. In the different reports that have been put into our hands there is pretty frequent reference to gales. Are these gales frequent; I am not speaking of cyclones?—Not cyclones?

12. No.—The gales are not frequent. The months of November and December are generally more or less stormy, with the wind between north and north-east. Those are the only winds which, as winds, are of very much importance.

13. Do gales of wind occur from the south-west, or, rather, I should say, with the south-west monsoon?—No, not gales of wind with the south-west monsoon. The seas come up from the south-east during the south-west monsoon, but they do not follow the direction of the wind at all. The month of May ought also to be noted as a month in which rough weather may be expected.

14. Is that one of the months of the south-west monsoon?—It is the beginning of the south-west monsoon, but the rough weather is almost always cyclonic then. I do not mean to say it is necessarily a violent cyclone at Madras.

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15. That is in the beginning of the monsoon in the month of May, is it?—Yes. There is almost always a certain amount of rough weather in the month of May, but I do not think that the direction of the wind in the month of May would be very regular.

16. As regards the harbour works, the north-east monsoon blows on shore, and the south-west monsoon off shore?—Yes.

16a. (*Sir John Coode.*) This diagram that you have put in does not give us any idea of the force, does it?—No, it does not give anything of the force, but merely the direction. You see that was made for drainage purposes, and to show the number of days in the year that the bad smells would be brought from certain quarters.

17. Then it is not much use to us, so far as force is concerned?—No. There is a memorandum here which was drawn up by the late Mr. Beardmore, who was assistant engineer on the works. It would not take many minutes to read it. You can then judge whether it is necessary to put it on the notes. Shall I read it to you?

18. Yes, if you please?—"The Indian climate is "divided very much into the north-east monsoon "(Arabic for season) and the south-west monsoon; or "another description may be given by dividing the year "into three portions: the cold season, the hot season, and "the wet or rainy season, of about equal duration each, "but this does not apply quite to the whole of India. "In Madras the north-east monsoon commences about "the middle of October and ceases about the middle or "end of February. This is the rainy monsoon in "Madras, and the rains, which are heavy, fall in two "periods of about a fortnight each in November and "December. Very little rain falls in Madras from "the 1st of January until July. The south-west "monsoon, with not a large quantity of rain, com-"mences about the 1st of June and ceases at about "the end of August. In the north-east monsoon, the "wind generally blows from the north-east and east-"north-east day and night. In the south-west monsoon "the winds from 8 o'clock in the morning blow pretty "strongly from the west and south-west. They change "in the afternoon (varying from 2 to 5 o'clock) to the "phenomenon (caused by the rarefaction of the air in "the hot plains of the land) of the sea breeze from the "east and south-east. Towards 7 or 8 o'clock in the "evening these winds veer generally through south to "south-west and west, blowing sometimes pretty "strongly from 9 p.m., when they get fairly in the "western quarter to midnight; and more or less gently "after midnight, until 8 o'clock in the morning. Rain "storms during the south-west monsoon generally "come from the west and sometimes from the north-"west. In the interval between February and June "the winds are variable. During the latter part of "February and March they are often light west-north-"west from the land in the early morning and easterly "from the sea in the afternoon. These are succeeded "for a month or often for six weeks by southerly "winds, known in Madras as 'Longshore winds.' "During the time they blow the climate in Madras is "exceedingly moist and unpleasant, and, to Europeans, "often unhealthy. In the month or six weeks interval "in September and October between the south-west "and north-east monsoon the winds are light and "variable, and frequently the sea and atmosphere are "almost calm. This will also occasionally occur for "a fortnight or so in February at the close of the "north-east monsoon. The months dangerous for "shipping are November, December, and May, as "during these, cyclonic storms are likely to occur, and "sometimes cause great destruction, as, for instance, "in May 1872 and November 1881. Unfortunately "there is no trustworthy record of the height of the "waves on either of those occasions, but they are "supposed to have been 15 or 17 feet from trough to "crest. On other occasions the sea at Madras, although "seldom quite still, is not often very heavy. During "November and December and sometimes during "January, the sea is, generally speaking, rough and "stormy, but not heavy." This was written in June 188-, after Mr. Beardmore had been nine years in Madras, and he had been in pretty constant communication from time to time with the astronomer, who is at the head of the meteorological observatory there, so that I think this may be depended upon as a general resumé of the facts as regards the climate and the winds.

19. (*Chairman.*) What we want to arrive at, is the wind as it affects shipping?—I may say, with regard to that, the wind hardly affects shipping at all, except in the months of November and December, and occasionally in May. Our works have been, as a rule, almost stopped in November and December, and not always in May, but sometimes they have been delayed in May, but during the remaining portions of the year they have gone on with very little interruption.

20. (*Sir John Coode.*) While we are on the subject of winds, I turn to the report of the Hawkshaw Committee of 1884. There is there a paragraph which reads thus: "Though the Madras Committee say 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 these prevailing winds." Now it is evident, in the face of this diagram, that that is a misconception?—It is a misconception with regard to the prevalence of the winds. With regard to the strength of the winds it is perfectly correct.

21. Then you have referred back to the report of the Madras Committee, and this is quoted right?—I noticed, directly I saw the report of the Hawkshaw Committee, that there was a slight misconception there with regard to the prevalence of the winds.

22. You see the Hawkshaw Committee were under the impression that they were the strongest winds, and you say the correct interpretation of it is, that they are the strongest, but not the prevailing winds?—Yes. Is that the Madras Committee you are quoting from?

23. I was quoting from the Hawkshaw Committee's Report, which quotes the Madras Committee.—It would be well to refer to the report of the Madras Committee.

24. Sometimes you get a very heavy sea before you get the wind, do you not?—Before the wind comes the sea generally comes in. The heaviest sea occurs some hours before the wind.

25. In fact, this is one of the cases in which we must not regard the wind alone, is it not?—Quite so. One thing has been most clear to me ever since I have been acquainted with Madras, that is, that you must separate the seas and the winds. The seas are generally in advance of the winds, not universally, but generally. At any rate, they come by independent laws of progression. Last November there was a cyclone in which this fact was very marked. The sea came in very heavily and even attained its maximum force, while the wind was quite gentle; then, a few hours afterwards, the wind got up to its maximum force, but the sea did not rise any higher.

26. (*Chairman.*) I think we had better deal with the wind first, and then come to the seas.—Yes.

27. (*Sir John Coode.*) Is there any source from which we could get more accurate information as to the relative force of the wind from different quarters than you have put before us in this diagram, because these are only days?—I think the other diagram which I laid before Admiral Salmon just now shows that:—"Polar projection of the annual relative force, or "number of miles registered from each point of the "compass at Madras from six years' records;" but then that does not give you the maximum force from the different quarters. That could only be got by searching the records. I have gone into these matters pretty closely. I went to Madras in 1878, and I went through these records to see mainly what was the course the weather followed during cyclones, and I found that, except in cyclones, there was very rarely—I think probably you might say never—any wind that would really affect any question of harbour shelter. They were generally very light unimportant winds, and whenever we saw the record of a strong wind we found that it followed the cyclonic laws. I think there is only one exception to that, and probably that exception might have been explained if our record had been a little more complete.

28. (*Chairman.*) I think now we come to one of the points that I want to get your opinion upon. Do the gales of wind so often mentioned in these different reports take one direction, or do they come from any quarter. What I mean is this, do the gales of wind mentioned in those reports occur as stronger north-easterly winds or as stronger southerly winds, or do they come independently?—They come independently of the prevailing wind of the season.

29. And from any direction?—They follow the regular cyclonic law. I suppose you have not got among the papers referred to you my original report dated 1873. It is the first report I made upon the subject.

30. This is it (*handing a document to the witness*).—In the Appendix to this Report I give the cyclones and other storms at Madras recorded at the Government Observatory, beginning at 1787. The way in which I got this was simply by looking through the record with the astronomer, who was very kind in giving me assistance. Wherever we saw a record by the diagram of a strong wind we noted the circumstances. Now, on the 11th November 1787 the wind at noon on the 10th was north; midnight, north-north-west; at sunrise on the 11th, north-west; noon, north-west; after sunset, violent and veering all round the compass; on the 12th, at sunrise, south-south-west; noon, south; 13th, sunrise, calm. Now that indicates a cyclone of which the centre struck the coast north of Madras. Then there follows another on the 7th May 1788. Probably I need hardly go through this. It is very much the same course.

31. Excepting that there is one thing which strikes me about that, that is that the date of the first mentioned is during the north-east monsoon, and the date of the second is at the time you would expect a cyclone, that is at the change of monsoon?—Yes, in May. The first is in November, the next in the following May.

32. Is the first one you mentioned also during the change of monsoon? What are the months?—November. November is the beginning or early part of the north-east monsoon.

33. But after the change?—After the change. The change is supposed to come in October, but the cyclones do not generally come till about the middle of November.

34. The second one, therefore, has more of the recognised character of a cyclone than the first?—Yes. The two are very nearly together so far as their cyclonic characteristics are concerned; but then added on to the cyclonic characteristics of the November storm is the prevailing north-easterly wind of the monsoon, but you see it comes down to a calm; it ends with a southerly wind, and then becomes calm. Then after that the wind would come round again to the north-east, and blow a very gentle wind indeed. The 7th May is very much the same thing: sunrise, north-west; noon, north-west; midnight, north-west; 8th, sunrise, west; noon, west; midnight, south-south-west; 9th, sunrise, south-south-west; noon, south-south-east; midnight, calm.

35. I think there is no occasion to go through them; we can put those in if necessary.—I should just like to show you the third class of cyclones. Of those two the centre was north of Madras. The next one is where the centre is at Madras. It began from northward, veered to north-east, blew with uncommon violence three hours; about noon suddenly shifted to south, and was almost as violent as before.

36. (*Sir John Coode.*) Does it say which way it went round to the south?—It was a calm between the two. That is the characteristic, I believe. Sometimes the centre is a little one way or the other. It will go round in one or the other direction, but that appears to have been purely central. Now we come here to the next, the centre of which was south of Madras. It began from north, veered to southward of east, and slackened gradually. When the centre is south of Madras there is no westerly in the wind at all, but it gradually works away to the eastward, and it has never been known to maintain its force after it reached the eastward. The records continue up to the 1st May 1872, which was the great historical cyclone when numbers of ships were lost. Since then there have been very few to be called cyclones, but I have the particulars of such as there were.

37. (*Chairman.*) It is more with reference to the strength of the monsoon that I was asking than as to the cyclones. We must take it for granted that the cyclones are exceptional winds, one of which has destroyed the harbour works?—Yes.

38. And that those must recur occasionally. With regard to the general winds; the force, you say, of the north-east monsoon, which is the stronger of the two, and most likely to affect shipping lying off Madras, is rarely sufficiently strong to be a danger to ships at anchor or to interfere with the loading and unloading?—Yes, I was just thinking that I might, perhaps, put that into authoritative form by a paper written by Captain Taylor.

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39. (*Admiral Sir George Nares.*) In those papers, as far as prevalence goes, it appears that between north and north-east and south and south-east are the most prevalent winds from the sea?—South and south-east are, I think, the most prevalent.

40. And eastward of north-north-east; east winds are of rare occurrence?—East winds are of very rare occurrence, undoubtedly.

41. There is no comparison between the east winds and either the north-easterly or south-easterly winds?—No.

42. The same with the force; if we take three points between north-north-east and north-east it appears there is an average of 2,598 miles in the year; if we take three points between south-east and south-south-east there is an average of 4,234 miles in the year, but if we take three points between the east by north and east by south, there is only an average force of 1,133 miles?—Yes, that is, undoubtedly, the general characteristic.

43. Therefore, in effect, the very strong south-easterly winds would not affect shipping so much because the wind is not directly on shore?—Coming from the south-east, you say, a south-easterly wind?

44. You said to Admiral Salmon just now that the south-easterly winds did not affect shipping very much, or so much as the north-easterly winds?—No, certainly not. They are not nearly so strong.

45. But if this paper says that they are stronger it must be that they do not affect shipping for some reason other than their strength?—That paper would show that a greater number of miles is blown from the south-east in the course of the year, but that is divided amongst a very much larger number of hours. I am afraid those papers hardly give you what you want to arrive at.

46. Then they tend to mislead; that is, as they show at present?—As a matter of fact, a south-easterly gale of wind, I believe, is almost unknown at Madras. A north-east gale is known very well, but there is a great deal of nasty swell comes up from the south-east, which causes a good deal of trouble to shipping.

47. (*Chairman.*) You may say that anything to the eastward of south is blowing on shore, as well as to the eastward of north, may you not?—Yes, is is not quite so.

48. Still that is near enough, practically. I see by the paper that you have shown to the Committee that the duration of the winds from the southward of east is greater than from the northward of east?—Probably it is; and not only that, but it must be remembered that the south-east winds take into account the afternoon sea breezes, which are blowing for many hours every day, which you may call simply local winds, and they do not affect shipping in the slightest degree.

49. (*Admiral Sir George Nares.*) You mentioned that your works were stopped in November and December, and that the wind affected shipping then. Were your works stopped on account of the winds or on account of the waves?—On account of the waves.

50. And were the waves produced by the prevailing wind at the time?—That would be very variable. I must say that I have had a growing impression that almost every sea at Madras is more or less due to distant cyclones. I did not at all start with that idea, but it has grown upon me. It is difficult to test it from time to time, still that has been the result of a good many phenomena which I have noticed.

51. With the north-east monsoon are the waves breaking over the north-easterly arm continuously?—Yes. As a matter of fact, for several months in the year we cannot load our stone boats on the north side of either pier, and the remaining months we cannot load on the south side of either pier.

52. Then the south-easterly wind causes the sea to break continuously over the south arm?—Yes; that is, frequently; I will not say continuously.

53. Would one be more continuous than the other?—I think not. I think, perhaps, I might say this, that if you combine the continuous character with the strength, the two would be about equal. There is a longer continuance of southerly seas, but the northerly seas are stronger. I shall be able to give you some particulars of a special south-easterly sea, and the effect of the harbour upon it.

54. Does it vary during the day and night; does the sea die down much in the night?—I do not think so.

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55. (*Chairman.*) Will you please first tell us what is the general direction of the sea; does it take the direction of the wind or is it affected in any way?—It seems to be quite independent of the direction of the wind, so far as I can see.

56. What is its direction?—It varies a little north of the line, perpendicular to the coast, and a little south of that line. I should say that, perhaps, probably the heaviest seas we have had are about from due eastward, but we have had heavy seas from the south-east, and also from the north-west. I cannot give the exact points, but about that.

57. Then there is always a swell setting directly on the shore, independently of that caused by the prevailing wind, is there not?—Yes.

58. That, I understand you to say, is nearly, if not quite, in a line with the shore?—Yes. Perhaps it would be interesting if I were to mention one fact, showing that the resultant effect of the southerly seas is greater than that of the northerly, and that is that there is a constant annual accumulation of sand from the southward.

59. We will come to that accumulation afterwards. It is more with the sea as affects shipping, at present, that we want to deal. Then ships lying outside the harbour will be lying broadside on, or nearly so, to the sea, will they not?—Yes.

60. How far does the sea break from the shore in the ordinary monsoon weather?—I do not know. I cannot be very exact as to this.

61. I mean, of course, where does the surf commence?—It depends upon the strength of the sea, but in ordinary weather (such weather as would not interfere with landing and shipping proceedings), say 200 yards from shore.

62. Not more than that?—There may be about three lines of breakers; that would be in moderate weather.

63. What is the extreme you have known it break?—The extreme is very difficult to decide upon, but Mr. Thorowgood, the superintendent, thinks that in very heavy seas it has broken in about seven fathoms.

64. (*Sir John Coode.*) That will be outside the entrance, will it not?—No, the entrance is eight fathoms, but my own impression, I must say, is, that we were very close to the break when these works were knocked down.

65. Then you think that at the time of the cyclone of November 1881, the north and south arms were in about the line of break?—I should not like to put that forward as a matured opinion, but I have a strong impression that it was not far off it.

66. There or thereabouts?—Yes; during the cyclone of last November, Mr. Thorowgood again said that he considered that the surf broke in about seven fathoms.

67. Is it your opinion that that was the heaviest cyclone sea to which the works are liable to be exposed?—That is very difficult to say.

68. I know there is a great difference of opinion on this point, but I want to know what is your own view?—I should hardly like to say much about that; but if I am right in my idea that we were very close to the break, because if there were a heavier sea it would break outside, and that would rather help us. If we were well inside the break, of course we should not get so much forces.

69. (*Chairman.*) In the ordinary conditions of the sea, to what extent is it felt inside the harbour?—That is entering upon an entirely new question, with regard to which I have brought some evidence. That is an important question.

70. Hearing you speak of maximum height of wave, what I rather wanted to get at is this: Under ordinary circumstances, does the sea affect the loading and unloading of ships in the harbour?—There are very few days, I cannot quite say how many days, in the year that it would be prevented, but I should think when the harbour is completed, judging by what the effect was when it was for a short time in a complete state, or virtually in a complete state, that loading and unloading would not be prevented more than three or four days in the year. I can get you some notes to support that, but I have not got them with me.

71. And with special regard to the sea, is that loading and unloading carried out without much damage to the lighters and harbour craft?—I am not aware of any great amount of damage. I do not think there is any special damage. It certainly is very much better when they come inside the harbour, although it is no doubt virtually open, than when they are outside in the roads, exposed to the current.

72. We will come to that afterwards. Then we may assume that is impossible to take the direction and force of the wind as any guide to the sea?—Quite so. That I think may be put down as certain, as far as my experience in the matter goes.

73. Have you observed the difference of the distance from the shore at which the break takes place outside the harbour, as compared with that inside? Can you give us any idea of that?—No. I think when I come to give you the evidence that I have (a good deal of mine is necessarily second-hand), you will see it is not so much the distance from shore that differs as that it is confined to a particular part of the harbour, that which lies just opposite the entrance. Probably there may be some diminution, but there is not so much as one would have expected.

74. (*Sir John Coode.*) Do you remember that the Madras Committee did say that the heaviest seas yet observed have invariably been from the north and north-east?—I do not remember that.

75. Does that consist with your experience?—That quite consists with what I have always understood. The report says north and north-east seas from the north are out of the question, that is merely a long-shore sea which hardly exists. The north-east, I should say, is quite the extreme northerly point from which any sea can come.

76. Any sea of magnitude?—Any sea of magnitude.

77. The north-east being the northerly limit, what should you say was the southerly limit?—There may be occasionally very rare seas as far south as south-east, or even south-south-east.

78. Southward of south-east?—Southward of south-east; but as a matter of fact they are extremely rare.

79. That is to say, seas southward of south-east are extremely rare?—Yes. I will not say southward of east, but say southward of south-east. The worst seas undoubtedly are the seas which come from the northward of east within such an angle as it is possible for a sea to "get up" in.

80. Does Captain Taylor coincide in that opinion. I ask the question because I thought that somewhere he had expressed an opinion rather different to that. I am not quite sure; I shall have to refer to the papers for that?—This undoubtedly passed through Captain Taylor's hands.

81. I have an idea that at a more recent date he expressed a different opinion. However, I will search that out. I will not trouble you about it now?—Perhaps I am going to read you something of Captain Taylor's which rather bears upon this.

82. What is the nature of the evidence you are about to give us with regard to the seas: is it local authorities?—Local authorities in answer to questions of my own. It is with regard to the extent to which the seas are affected by the harbour, namely, during the short time that the harbour was in existence.

83. You mean to say the extent to which the force of the sea is quelled by the harbour?—Yes.

84. Then are these observations made during the time the harbour was intact?—It is hardly fair to call them "observations." They are the result of general observation. There were no actual measurements made.

85. Perhaps you had better put them in, read them, or tell us what they are?—I ought just to preface it by a little explanation. I was out in Madras myself in the beginning of 1881. I left in the middle of March. At that time the works were supposed to be approaching completion, and we had been considering what additional accommodation should be given for landing and shipping. We began to build some jetties. They are shown upon *this* plan. Those jetties were begun, the idea being to transfer the trade from the existing screw pile pier to *these* jetties, and then to alter the screw pile pier into a more convenient form for the altered conditions of work. The question was then arising how far these jetties would be sufficient in calm water for carrying on the ordinary business. I merely mention that just to show what may have been the bearing

of some of these remarks. I have here copies of extracts from Mr. Thorowgood's letters to me during the months of April and May.

86. When you say during the months of April and May, do you mean extending over a series of years, or confined to a single year?—Confined to the single year of 1881, and you will see by *this* plan what the opening was at that time. In March 1881 the north pier had arrived at its termination. On the 31st March 1881, the south pier had arrived at a point 370 feet short of its termination, and they were then advancing. It was between March and June that these letters were written. Now I ask you to excuse me from handing these in because they are private letters, and they contain perhaps some remarks that Mr. Thorowgood would not care to have published.

87. (*Chairman.*) You can read what you think likely to be of use to the Committee?—I will give you what I think is of use to the Committee.

88. (*Sir John Coode.*) Give us such extracts as bear upon the facts?—On April 5th he writes to me: "There "is a lot of surf inside the harbour with this south "wind, much to my distress, and when I was on board "the 'Kaiser-i-Hind' on Sunday last she rolled quite "unpleasantly. Yet the sea outside was a mere "nothing, just splashing over the south pier at odd "times. I do not doubt that 300 feet more of south "pier will make a difference, but I do not feel quite "happy about the waves in the harbour." Then a week afterwards he writes again.

89. Three hundred feet, he says. There was then a length of 300 feet more to be constructed?—On April 12th he writes, "Captain Taylor was away on tour when "I had a talk with Mr. Horne." Then he goes into the question of width of entrance. Perhaps I had better leave that.

90. (*Chairman.*) We will come to that bye-and-bye.

91. (*Sir John Coode.*) Who is Mr. Horne?—The harbour-master, he is called, and he had just been appointed.

92. Still he is a man who knew the port well, I suppose; why did Mr. Thorowgood take his opinion if he was not an expert?—He had had a talk with him, he says.

93. I want to know what Mr. Horne's acquaintance with Madras was, because if he was comparatively a stranger there it would not be worth much; if, on the other hand, he was a man of long experience at Madras, it would be more valuable?—He was a man, I think, who had commanded a ship.

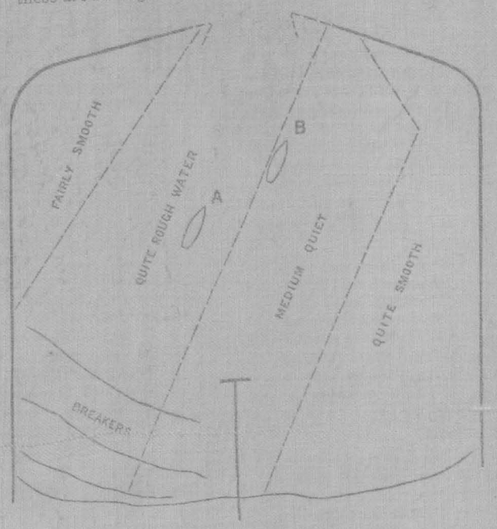
94. And who knew Madras?—He knew Madras well. Then he was appointed harbour-master and pilot, and went out to every ship, but at this time he had been only a month, or something like that, in office. Since then he has been six years, and I do not think his early opinions are of very much weight. However, we will drop that, because it has reference only to the question of width of entrance. I will come to that again. Then on the 26th April, three weeks after the date of the first extract I read, he writes, "The amount of surf and "movement in the northern half of the harbour is, to "my mind, very unsatisfactory indeed, and I have very "little doubt that anything like a storm from S.E. "would send all the native craft ashore, as in days of "old." I should tell you at that time the native craft were allowed to come in and anchor along the more sheltered side of the harbour.

95. (*Chairman.*) I intended to have asked you later if you could put in plans of the harbour showing the moorings?—There are no fixed moorings. They simply anchor. We have a plan for moorings, but after the accident in 1881 we suspended the completion of it.

96. That is what I mean, before the accident?—None were fixed. They were being fixed at the time, but I think only one was actually put down, and that was not used. "The southern half is, however, perfectly "smooth, and the shelter for passengers embarking is "most excellent." This, you will observe is in April, when the southerly winds are prevalent and the southerly seas. Then, on May 10th, he writes to me, "The sea throughout the last five days has been heavy "from the south-south-east, and there is a terrible "amount of swell inside the harbour, the waves "breaking over the blocks on the south side of the "north pier. The more I watch this swell, the more "convinced do I feel that the horns will have "hardly any effect. The disturbance is the direct "action of the seas coming in at the entrance—the "running round the wall does not add any force to the "waves." The horns were intended to prevent that, but he says, from his experience, that they would not be of much use. Now, this is important: "There are "five steamers in harbour now, and A and B are the "positions of the (A) 'El Dorado,' and (B) 'Poonah;' "these are rolling and pitching more than I like."

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97. That is also in May?—Yes, that is May 10th.

98. (*Sir John Coode.*) Would you just hand to the Admiral the sketch?—Yes (*handing the same to the Chairman*). That is rather important. That is made at the time, without any idea of changing the position of the entrance. Then he speaks about some alterations at the entrance, but not of any change of its position.

99. Does he say what are the conditions of the southern half of the harbour at that time?—The conditions of the southern half of the harbour, "quite smooth."

100. He writes that on the sketch, does he?—Yes, that is on the sketch. This is with a wider entrance than was then intended, and, of course, this "quite rough water" would be reduced in width in proportion to the reduction of the entrance.

101. What was the exact date of that letter?—May 10th.

102. He had not then much more of the work to do?—No, there was not much to do. I think it was about a 700 feet opening then. Then he goes on to say in a way that it is not necessary to quote, that he is rather troubled at it, and he adds this: "There is one com-"fort, however, and that is that we do not often have "a heavier sea than the present, unless it be the result "of a cyclone, when we do not claim a great advantage "in our harbour." The following is written a week later: "But if the water inside the harbour is not "going to be a great deal quieter than at present "with a southerly sea, I see very little chance of doing "away with masula boats. The (Madras) 'Times' "had an article, written very fairly and not bitterly, "lamenting that although the harbour was nearly "finished the surf remained almost as of old. Well, "the only thing to do is to accept the position. There "is always *some* spot in the harbour where the sea is "fairly smooth, although we cannot claim to have "made the Madras surf a thing of the past." Mr. Thorowgood then was going away on leave for two or three months. I therefore wrote both to Captain Taylor and to Mr. Boardmore, asking them to give me their ideas of what the effect of the harbour was upon calming the water.

103. Upon the subject of the state of the port?—Upon the subject generally, and to do it in a systematic way. I asked Captain Taylor to make his report officially to the Government, and I think I cannot do better than read you my letter to him, which will show you what I asked

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for. This is written on the 10th June, and therefore a few days after I received the letter that I have just read to you from Mr. Thorowgood. "My dear Taylor,—"In his recent letters to me Thorowgood has given me "the results of his observations on the amount of "shelter afforded by the nearly completed piers during "the southerly and easterly seas lately prevalent. He "expresses himself as somewhat disappointed in the "effect produced, and signifies that a similar feeling is "expressed in other quarters. Too much importance "must not be attached to such expressions of disappointment. The anticipations with which the still "incomplete reality is compared were necessarily based "on very indefinite grounds, and some disappointment "is quite consistent with the fact of very important "practical results having been attained. But I think "the existence of these feelings of disappointment "makes it desirable that there should be some authoritative statement of the positive results which have "been already obtained, and of the degree of further "improvement which may be anticipated from the "completion of the works. To defer this till the piers "are complete would virtually be to defer it for a year, "for it will not be till May 1882 that the seas will "again be prevalent from the quarters which are most "completely effective. By that time the harbour works "establishment will be broken up, and if any questions "should arise it would be discussed as a disadvantage. "It cannot now be difficult to make allowance for the "difference between the present opening of 750 feet "and the ultimate one of 550 feet in admitting the "swell. What I would suggest therefore is, that you "should report to the Government how far, from your "own observation, you think the number of ships which "may be expected under ordinary conditions of trade "to be in the harbour at one time can be berthed in "water sufficiently calm to allow of cargoes being "discharged and shipped at all ordinary times, and "how far at the same time the landing jetties, or at "least one of them, will be sufficiently under shelter "to allow the cargo boats to lie alongside them. You "would thus indicate the limits of the accommodation "which the harbour will afford, and from this a judgment could be formed as to the best way of extending "those limits immediately if necessary, or at some "future time if an increased trade should call for it. "If your opinion be that the works now sanctioned "will suffice for the immediate requirements of the "trade, the immediate objects for which the harbour "has been constructed will have been attained, even "though the results be not quite so much in excess of "that immediate object as you, or I, or others may "have pictured to ourselves. I need not tell you that "there are various ways of making the shelter more "perfect by supplementary works, the cost of which "would be small compared with the amount already "expended, but it would be premature to discuss the "relative merits of these until the necessity for them "is shown to exist." That was dated the 10th June 1881. On the 18th July Captain Taylor wrote to the officiating Chief Secretary to the Government to this effect: "I have the honour to forward herewith, for "the information of his Excellency the Governor in "Council, a letter in original from Mr. Parkes, in "which it will be seen that he considers the time has "come when a decided expression of my opinion as to "the advantages to be offered by the harbour in its "present form, and generally as to the success of his "work, should be given. This letter is one that I "cannot answer without the sanction of Government "or without previously putting Government in possession of my views on the various subjects it draws "attention to. I would, therefore, respectfully advance "my opinion that, as an improvement towards carrying "on the trade of the port and remedying the former "serious disadvantages of Madras, the harbour bids fair "to answer well, and will richly repay the dues in the "shape of landing and shipping charges and increased "port dues, which the trade will be called upon to pay "for its relief from the loss, danger, and exaction to "which it has hitherto been compelled to submit, and "which has given the port its former evil reputation. "The periods of rough weather (independent of cyclone "weather) are very few, and never last long, and "though during such periods some inconvenience and "delay are sure to occur, yet there is probably no port "in the world which is not weatherbound for as long "or longer period. So far a great practical benefit "has been conferred on Madras by Mr. Parkes' works, "and it is to be hoped that the benefit will be lasting." That is Captain Taylor's official reply to my question.

I will now read you Mr. Beardmore's letter; this is dated the 17th July 1881. "I should like to defer, until "another mail, giving my opinion as to the amount of "protection afforded by the piers during the S.W. "monsoon. I will row about in a boat and examine "carefully the amount of swell which enters the "harbour; but I am sure of this, that since we have "got down the 11 courses at the south pier, and four "at the north pier, after the period of cessation of "work in May, the amount of motion inside has been "evidently and very decidedly less. We have had "very much more rough weather since the 1st July "than in May and the earlier half of June, and I think "the swell in the middle of the harbour has been "nearly half the height at the later period than at the "earlier. I am under the impression that the water "south of a line between the southern corner of the "T head of the iron pier, and the end of the south "pier, is almost smooth." You will see what that means by the plan. That is the 17th July. On the 4th September, some seven weeks later, he writes again: "Since my letter to you of 17th July, we have "not had sufficient rough weather to enable me to "make further observations and confirm thoroughly "the opinion expressed in that letter. I have "frequently observed the ships from the shore, and "have been out in a boat whenever there has been "anything like a lop on the sea, but yesterday week "was the first day we had anything like a blow, and "then it was only a little breeze, and we had the same "on two days last week. I am all the more inclined "to think that the opinion I have expressed will prove "to be correct, viz., that even in very stormy weather "the area within the harbour, south of a line from the "S.E. corner of the T head of the iron pier to the end "of the south pier, will be moderately quiet, and that "in moderately stormy weather ships will always be "able to load and discharge cargo there with great "ease. Within that area I have seen moored three "steamers, a ship, a barque, a brig, and three or four "country dhonies, with ample room for one other "large vessel, either ship or steamer." That, of course, is speaking with regard to the seas from the southward. It would be simply reversed with the seas from the northward.

104. (*Chairman.*) This all rather seems to me to point to the sea accompanying the wind and not to the independent swell that is always setting on the entrance?—There is no doubt that the seas do come from south of east during the south-west monsoon, and from north of east during the north-east monsoon, and that the opposite halves of the harbour would be more disturbed during those two periods.

105. (*Admiral Sir George Nares.*) Have you any observations where the change of direction of the swell takes place, because out in the offing it must come in directly with the wind?—It is beyond the range of our observations where it takes place. Originally I was under the same impression that in the offing, and even where the ships were anchored in old days, that they would head to the north-east in the north-east monsoon. It is not easy to get it, because it is a flat shore, and it is difficult to get a view, but I do not think we have ever observed the place where the sea does come from the same quarter as the wind, unless it is slight seas. They follow the wind undoubtedly.

106. (*Sir John Coode.*) The seas are invariably parallel to the shores, then; is that what you mean?—The very heavy seas are parallel to the shores, very nearly.

107. For all practical purposes?—Yes.

108. (*Chairman.*) "In no case," it says here "is it "believed that the angle exceeds 30 degrees to the "general line of the coast." That is the Madras Committee.—That view is a good deal confirmed by our observations of the action of the sea on the sand of the beach. A light sea which would come more truly from the north-east will cause the sand to travel, and will cause it to accumulate, but a heavy sea with the wind in the same direction will carry it out to sea.

109. I think that we must put off that matter until we come to the sand.—I merely mention that as illustrating the different action of the light sea, a sea raised by the local wind, and the heavier sea which does not follow the wind but is parallel to the shore.

110. I think we had now better come to the currents and tides. Can you give us any information with regard to the currents and tides?—With regard to the tides, they have now been very thoroughly examined.

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I am afraid I cannot give you the exact figures. The exact figures of all the tidal elements have been determined by Major Baird, R.E., but owing to the "diurnal inequality" the results are not easy to give in a simple form. But the rise and fall of the tide is really not an element in the question. It is an extreme, I think, of 3 feet, and an average of something less than that. The tidal current is not sensible. There is no sensible difference in the direction of the current according to the time of tide. There is, in fact, no tidal current whatever. Mr. Beardmore fancied that he got a tenth of a mile per hour or something like that.

111. Then there is no tide or current to affect a ship entering or leaving the harbour?—No, I can quite say that. There is no rise and fall of tide and no tidal current to affect the shipping entering the harbour, but there is what I presume is a wind current, or what was originally due to a wind current, but which I have reason to believe is purely a surface current, which runs from the southward during the south-west monsoon and from the northward during the north-east monsoon. That ordinarily does not exceed a mile an hour. There are occasions on which it has been said to be as much as three miles an hour, but I do not know of any observations to prove that. There is no doubt it is variable. It is the general opinion that it gets up to sometimes three miles an hour, but I have never heard of its being measured. A mile an hour is an undoubted fact, but it is not regular. Sometimes there is a current, sometimes there is not.

112. And that would depend upon the prevailing wind and the strength of the prevailing wind, would it not?—I should not like to give any opinion as to what it depends upon, because the observations upon it have been so very little. They really have been very little more than watching the way in which the ship's head lies.

113. (*Sir John Coode.*) Do you think there is no reliable source from which we can get information of that nature?—I do not think so. There is nothing more than what you can see on the marine charts, and they give that note. I dare say in this office there would be a copy.

114. (*Chairman.*) But you had this subject under consideration when you made your original report, had you not?—Yes, I think you will find it is alluded to there.

115. And you quoted in it the master attendant's letter, that is, Mr. Dalrymple's letter, in which he speaks of "Unless the strong current flag is flying"?—Yes.

116. How is that strong current ascertained?—That would be ascertained by the officers of the marine department on shore, and as boats are passing constantly to and from the ships, if they find any difficulty in passing over the space between the ship and the shore, they report it, and then the strong current flag is exhibited and communication stopped for a time.

117. (*Admiral Sir George Nares.*) Or a double charge made?—Yes, if it is possible to make the passage at all.

118. (*Chairman.*) But there is no calculable current?—There is no calculable current, nothing that we can say is constant.

119. (*Sir John Coode.*) Would not the fact of there being a special strong-current signal, in your opinion, seem to point to the fact that there is a current which materially affects the navigation?—It simply affects the boats, it does not affect the ships at all. If the current is stronger than the wind they lie to the current. If the wind is stronger than the current they lie to the wind.

120. Then this is for the guidance of the boats passing to and from the shore?—Yes, I do not think it has anything to do with the shipping.

121. Do you think that Captain Taylor will not have any observations he can give us of that?—I do not think so. I do not think I have ever heard him make any difficulty of that current as regards the harbour.

122. (*Chairman.*) Of your own knowledge are you aware of ships ever lying across wind and current directly, in fact, with the current opposite to the wind?—Yes, I have seen them lie across wind and current, between the two, and they lie, of course, very uneasily; but that is one of the evils, and the attendant evil, of the boats coming alongside them, that we get over by the harbour, because they are there completely protected from the current.

123. That points to the current at times, certainly, not being in the direction of the winds?—The current is almost necessarily parallel with the shore. The wind may not be parallel with the shore, but when the winds are prevalent from a quarter north of eastward then the current runs from the northward. When the winds are from a quarter southward of eastward then the current runs from the southward.

124. That does not agree with the ships lying across the current?—Yes, I think it does, because the wind may be south-east and the current would be south by west.

125. (*Sir John Coode.*) Do not you think these currents are what are called in Ceylon monsoon currents at a particular period of the year?—There is no doubt that they are monsoon currents. They follow the change of the monsoon. They do not follow the daily changes of the wind.

126. That would point to the fact that they are monsoon currents, would it not?—They are monsoon currents. They follow, in fact, the prevalent wind, but they are extremely irregular. But the conclusion that I came to in the early stages of this undertaking was that really this current did not affect us at all.

127. You did not take observations upon the currents, did you?—I do not know that I made any personal observations—I think not. Observations have been made during the progress of the works, but it all came to this, that they were extremely irregular, but that, as a rule, during the one part of the year, they came from the south, and the other part of the year from the northward. They were never the same two days together.

128. (*Chairman.*) It appears by this report that there are no records of any systematic observations of the direction of the swell or of the currents and their strength at different seasons. That is 1882, after the harbour was destroyed.—Of course I need not tell you that I gave a great deal of consideration to the matter of this current, but I came to the conclusion that it really did not affect us ultimately.

129. (*Sir John Coode.*) Have you yourself ever measured a current so much as 3½ miles an hour?—Oh, dear, no; and I cannot quote anybody who ever has.

130. Can you refer to notes you made at the time and tell us what were the general results?—I think nothing more than what Admiral Salmon has just read from my original report. It does say upon that at the time I was at Madras originally there was no current.

131. (*Admiral Sir George Nares.*) Whatever current there was out in the offing with the monsoon the harbour works would increase the velocity of the water passing close alongside the works themselves, would it not?—As a matter of fact, they did not. I do not think that we ever met with the increased strength of current which you would suppose would be caused by the works advancing, but I think you will have a witness before you who can speak more positively to that; that is the foreman of the works, who has been there from the beginning, and he would tell you whether there was ever any current that the divers could appreciate. My impression is that there was not.

132. (*Chairman.*) Then you are not disposed to agree with Captain Taylor, who estimates the average strength of the current as two miles an hour?—No, I do not know where that comes from, and I have certainly not the least idea that there is ordinarily such a current as that.

133. (*Admiral Sir George Nares.*) There might be a current in the offing due to the monsoon, but you have not felt it near the harbour?—No. The only observations that I have ever made were when those works were quite in their commencement. I many times went out to the head of *that* pier and timed the time of a float from one end to the other, and it really was perfectly insignificant. There was just a drain one way or the other. But there is no doubt it is stronger out in the offing.

134. (*Chairman.*) I think we had better now come to the movement of the sand. Can you give us some account of the movement of the sand?—*Here* is a plan which shows the effect for a series of years up to 1884. *This* is the original line of high-water mark before we began work.

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135. What was the date of commencing work?—1876 you may call that; the first year was devoted to carrying out the north pier, and there was a great accumulation of sand. The north pier was carried out some little distance first. About as far as B on the plan.

136. (*Sir John Coode.*) If you can give us the distance in yards, about, it will make it much clearer upon the notes, and will be understood as one reads the evidence, —say from the original shore line?—About 200 yards from the original shore line. During the south-west monsoon the sand accumulated to the south of that. During the following north-east monsoon about half of that accumulation was swept away again to the southward. Then the following year, 1877, we commenced the south pier, and carried that out about the same distance. During the south-west monsoon following that there was an accumulation to the south, and the portion of coast between the two piers was drifted away to the northward, so that it formed a line intersecting the previous line in the middle, it being more in-shore at the south and more out-shore at the north. Then, after the north-east monsoon following that, a portion of the accumulation was swept away from the south of the harbour, but leaving an advance of about 200 feet.

137. (*Chairman.*) From the original line?—From the original line, and also on that occasion there remained (I think it was) about 100 feet—it is not shown upon this plan—within the harbour between the two piers. That was the only occasion on which there was any such advance within the harbour.

138. To finish up the inside of the harbour, there has been no advance in the inside of the harbour since that, has there?—There has been a slight advance, but nothing that we could attribute to any sand coming into the harbour. It was all accounted for by a little deepening which took place here (*pointing to the plan*). This part was deepened, and the sands washed up *there*, and that quite accounted for it, with, perhaps, something for the sand blowing over from the southward.

139. Then you think there is no steady annual increase inside the harbour?—No, certainly not. There are changes sometimes, but it is not more than one can fairly attribute to the slope being sometimes flatter and sometimes steeper; but on the south side the advance has been annually like *this* (*pointing to the plan*).

140. (*Sir John Coode.*) Does that continue to advance?—That continued to advance until this last year, which has been an exception. That was the first occasion on which we had a May cyclone. In May 1886 there was a cyclone.

141. (*Chairman.*) We had better, perhaps, go as far as the lines go. We will finish the regular advance before we come to the exceptional case which came so late. What has been, since the commencement of the works, the annual rate of increase of the sand on the south side?—It has been a diminishing rate, and up to March 1884 it has advanced. From 1876, say, to 1234, from the original line, it has been nearly a thousand feet, and now, in 1885 and 1886, it showed an advance at something like the same rate, rather diminishing; but in 1877 it shows, for the first time, a little retreat.

142. (*Sir John Coode.*) When you say "a little," can you give us an idea of how much?—I think the 1877 line very nearly coincides with the 1885 line.

143. What is that in yards?—That is a little bit outside here (*pointing to the plan*). There was an increase between 1885 and 1886. Then between 1886 and 1887 it washed back again to where it was in 1885.

144. (*Chairman.*) Then the present line of sand is, from the commencement of the works, how much?—This would be about the three-fathom line (*pointing to the plan*). The six-fathom is, I think, very little advanced. Up to last year there was never any advance outside the six-fathom line; but last year, when we found that this had washed back a little bit for the first time, we found a little shoaling out here (*pointing to the plan*).

145. A gradual shoaling for the whole length?—I can hardly say that it was gradual. It is only about 2 feet *there*; but this 7½ contour, I think, now comes out to about there (*pointing to the plan*). I can show you the exact thing.

146. (*Sir John Coode.*) I suppose we may take it for granted that previously to the commencement of the works the contour lines were parallel to the shore for all practical purposes?—Yes; and outside the six-fathom line they have remained parallel until this last year, and this is only a very very slight exception.

147. (*Chairman.*) Has there been any deposit of sand on the back of the breakwater itself?—Only as it advanced *here*.

148. Take *this* as the shore line, has there been any deposit of sand *here*?—No, all *this* is perfectly clean, or was. I will not say whether, since we observed this little shoaling out *here*, there may not have been a little deposit on *that*; but certainly, until quite lately, *this* has been perfectly clean outside. I will say, to be within the mark, three fathoms. Within three fathoms it is buried in sand.

149. (*Sir John Coode.*) When you say "it" is buried, you mean the whole of the rubble deposit?—Yes, the whole of the rubble deposit.

150. (*Chairman.*) Has the advance been greater on the line of the breakwater than on the general shore?—Yes. The line of the breakwater forms the base of a triangle. It runs out to nothing, some two miles out to the southward. Then, on the north side there is a corresponding erosion. We have protected the shore line for half a mile artificially, and beyond that, where it would not pay for a protection, we have allowed it to be washed away.

151. (*Sir John Coode.*) Is that process still going on?—That process is still going on, but very slowly.

152. Not to the same degree as at first?—No, not to the same degree as at first.

153. (*Chairman.*) Do you consider that there is no danger to the harbour works from that?—No, I do not think there is anything in the sand movement that affects the harbour works at all. As I tell you, for the first time there has been a little deposit near the bend of the south pier, and this is the first time since we began work that we have had really heavy weather in the month of May.

154. (*Sir John Coode.*) When was this bank at the knuckle first observed?—Last September; it certainly did not exist the year previously.

155. You have periodical soundings taken, I suppose, at least every year?—Yes, generally about every year.

156. How often do you have them taken?—Another day I will bring you the comparative soundings.

157. It is desirable we should see them and know what kind of process is going on.—We know perfectly well that for 10 years there has been no change *here* virtually (*pointing to the plan*), until this last year, and now it is really very slight indeed. We had a real cyclone sea in November, and our previous November experience of storms was, that they had very little effect upon the shore line—no permanent effect.

158. (*Chairman.*) You do not think it might have the effect of moving the sand which was deposited in the previous change of monsoon?—It might.

159. It is very important that we should get that, I think.—It would be rather interesting to find that, but I do not myself attach much importance to it. I think it is quite possible that the sand having been disturbed during the then the current was flowing from the southward, it was stopped there, whereas what was drawn away from the shore was carried rather to the northward by the current from the southward, and then when the stormy and heavy weather occurs in November the current is from the northward, and that carries whatever sand is washed out clear of our observations.

160. (*Admiral Sir George Nares.*) Any sea that would move the sand in eight fathoms would be inclined to deposit it in the quiet water under either the north or the south breakwater, would it not?—I do not know. I am hardly prepared to say what it would do if it moved in eight fathoms.

161. Before this shoal was found at the knuckle of the south breakwater, you say there had been unusually stormy weather?—Stormy weather in May.

162. From what direction?—The seas would be from a little south of east, but not very much. There is a piece of sunk wall standing there (*pointing to the plan*).

163. (*Sir John Coode.*) There is a plan showing the portions that are not washed down, is there not?—Yes (*producing same*). You see the inside wall there was left standing by the great storm of 1881. In May last year that was knocked over into the harbour. That shows that the sea must have been more southerly, I think, than the previous one, because the sea in 1881 would be nearly end on.

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164. (*Chairman.*) In view of the advance of the sand, and the deposits of sand at different points of the southern arm, you would not be prepared to entertain the question of opening out an entrance to the south-east?—No, I think it is a decided objection to any entrance to the south-east. It is so much nearer to the inevitable smothering in sand. I might mention this. The first year I made a very rough calculation that the entrance would probably be affected by the advance of sand in a hundred years. Two or three years ago I repeated this calculation with the additional data that we have got, and I found that it was very immaterial. It is a question of something like a hundred years when we may expect to be damaged by it.*

165. That, therefore, limits the question of the entrance to remaining the present position or opening an entrance on the north-east?—Yes, I think myself that that is a fatal objection to a south-east entrance.

166. Do you feel safe in assuming that the sand does not enter into the question of the north-east entrance at all?—No, I do not think that it affects the question of a north-east entrance in any way. In fact, the north-east entrance, so far as the sand is concerned, is better than the eastern entrance, because it is so much further off; but then the eastward entrance is one on which, I think, you need hardly consider the sand.

167. (*Admiral Sir Gorge Nares.*) Any entrance to the south-east would also prevent the best system of extension works afterwards, when they became necessary, at any rate more than an easterly entrance, or a north-easterly entrance, would it not?—It is difficult to say, unless one has some idea of what the extension works are likely to be. My original idea was that this might develop into something like Marseilles, a series of harbours adjoining one another, but I am inclined to think now that the right thing will be to extend the harbour inshore, dredge it out, in fact, rather than go out to sea. I think that would be the cheapest way of doing it.

168. (*Chairman.*) Have we a plan here that represents the work before it was destroyed?—This really represents it (*pointing to a plan*). *That* actually shows the state of the works in September 1881.

169. (*Admiral Sir George Nares.*) This is what is proposed (*pointing to the plan*)?—*That* is proposed, and I will show you how far it has gone. *This* is the state of things on 31st March last.

170. (*Chairman.*) These works were built on your designs, were they not?—Yes.

171. Will you tell the Committee, please, what governed the selection of the extreme easterly point of the harbour for the entrance?—Do you mean why I fixed upon that particular depth to go out into?

172. No, I do not. I mean the position?—I think you have my original report here, and you will see that the entrance is differently arranged in that. *That* shows a straight line instead of the projecting line facing the sea. I may say that the reason for that was the idea that I spoke of just now, that this might be extended on each side, and that it was just as well to avoid having the re-entering angles. Then, as we went on, we found by the change of the trade from sailing vessels to steamers that it was not likely that anything like the same number of ships would be wanted at the same time in the harbour, and that the plan then under construction was as much as was likely to be wanted for a great many years; therefore, the idea of extension north and south was dropped. Then the nautical people (as they naturally always do) tried to get a little more width of entrance. No very great objection was made to the 450 feet; yet they all said they would rather have 550. I think it was in 1878, when we were getting out to an extent which gave us some idea of what the amount of shelter would be, I came to the conclusion that we really could afford to give the other 100 feet of entrance, and that we might do that with some advantage by spreading out the arms more to seaward than is shown on the original plan, but keeping the same length, so that left 550 feet instead of 450. The main advantage of that is that it gives a greater space for a ship to bring up in coming into the harbour. That was sanctioned by the Government; it did not affect expense at all, and the works were then carried on upon that design.

* See paper in Appendix.

173. Still, with regard to the position in the centre of the outer wall, directly facing the sea (the prevailing sea certainly), what governed the choice of that position?—The thing was talked about a great deal in the original design. A great many nautical men were consulted about it. Some of them were in favour of sheltering it from the north, and some of them were in favour of sheltering it from the south. After a good many friendly discussions I think the general result seemed to be that it would be better to have an entrance that should give equal shelter from both sides. With the northerly seas this part of the harbour (*pointing to the plan*) would be well sheltered; with the southerly seas the other part of the harbour would be well sheltered. It was, in fact, the best compromise we could make.

174. So that a ship may round-to, with her head to the prevailing wind?—Yes, with her head to the prevailing wind.

175. And be under shelter from the prevailing seas?—Yes.

176. On either side?—Yes. No plan that occurred to me or that was suggested by other people, giving an entrance other than that, seemed to meet with much acceptance.

177. (*Sir John Coode.*) Was that submitted to a nautical opinion at the time?—Yes, I consulted a great number of nautical people about it.

178. Was Captain Taylor one of them, or was it his brother that you consulted?—Captain Taylor's brother decidedly was consulted. I was in frequent communication with him.

179. He was Captain Taylor's predecessor, was he not?—No, it was Captain A. D. Taylor, of the Indian Navy.

180. He was engaged on the marine survey, was he not?—Yes.

181. And he knew Madras very well, did he not?—Yes. In fact he and I together made up this original scheme. Then Captain Taylor, the present master attendant, gave his approval to this scheme, and when he was appointed master attendant, he said he should give us all the support he could, and it was while he was master attendant that it was sanctioned.

182. (*Chairman.*) And the works under those circumstances, with the entrance in that position, you think were sufficient to give shelter to the amount of trade frequenting the harbour to enable them to load and unload in fairly smooth water, and generally to facilitate the business of the port?—Yes, and I think that it does so. Even with the outer arm broken down it still is a very great advantage to the port.

183. Had you any idea at the time that the harbour was capable of giving shelter to ships in cyclones?—No, I never depended much upon that. There is no doubt that outsiders, and especially people of philanthropic views, think a great deal about that, and I think there can be very little doubt that it was the very great disaster of 1872 that brought this idea of having a harbour at Madras to a point; but, for myself, I never gave any prominence to that idea, and I do not think that any nautical man ever did so.

184. Can you tell us what were the port rules with regard to threatened cyclones; were the ships then in the harbour allowed to take what course they pleased?—I think they were, and I think they are still. A notice flag is hoisted on the master attendant's office, advising them to put to sea, but if they like to take the risk of remaining, I believe they may.

185. Have you any idea what view the insurance companies take as to that?—I do not know what view they take at all. I do not think, so far as I know, that the rates of insurance have been affected by the harbour as yet.

186. (*Sir John Coode.*) On the occurrence of a cyclone, before the harbour was constructed, were vessels in the habit of going out to sea?—Yes.

187. So that they do now what they did previously to the works being commenced?—Yes. I think I ought to say that it has always been an accepted fact that there is ample warning of the cyclones; and so I think there is so far as wind is concerned, but the sea does come in before the wind, therefore the warning is not sufficient as to the sea. Now, on two or three occasions within the last two or three years, there have been ships in some amount of danger in the harbour before any warning was given. The wind had not risen by that time, it was simply the sea.

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188. Do you mean to say there is less of warning of a dangerous rise in the sea than there is of the state of the wind?—Yes, it is this. The sea may come several hours before the wind, and it does so.

189. But is there less notice of a dangerous sea than there is of a dangerous wind?—The notice I am alluding to is the state of the barometer.

190. From which you can judge of the state of the wind?—Yes.

191. But not of the sea?—No; you cannot judge of the state of the sea.

192. Then does the sea rise so very suddenly from a moderate disturbance to a dangerous one?—Yes, it does come up very quickly.

193. Would you say within an hour or two?—Well, I could hardly answer that question. But what I want to convey is this, that there may be a very heavy sea running, and one that is evidently due to a cyclone almost before the barometer is affected by it. I believe that that might be remedied probably by more careful observations.

194. You mean by an extended series of signals along the coast?—Yes, more signals along the coast, but still these cyclones come in from the Bay of Bengal, and the first indication that they give to the ordinary people of Madras is the heavy sea that is sent in.

195. Then the sea will become heavy and dangerous even before the barometer is affected sometimes?—I will not say actually before the barometer is affected, but before much notice is taken of it. That is really a point which has come before me rather strongly on the last two or three occasions, on which we have had heavy weather at Madras. It has been put down as unexpected when it really appears to me that it is owing to a great extent, that the sea comes before the wind.

196. (*Chairman.*) Then under these circumstances a sailing vessel would not be able to get to sea, without the assistance of a steam tug?—No; but I think the sailing ships may be put out of the question now. As a matter of fact they used the harbour during the few months it was in existence, but immediately after that they were forbidden to come in, and they never have been in since. Steamers come in regularly. Steamers never hesitate to come in. The sailing ships are not allowed to come in; whether they might be allowed to do so when the harbour was again finished I do not know, but they are getting less and less in number every day.

197. And for that reason that they cannot escape without the assistance of tugs?—Yes; they cannot escape without the assistance of tugs, and there is no possibility of obtaining that assistance at Madras. That is the difficulty we have there. There is no shelter even for a steam tug. That is what I hope will be taken up before long, in order to make something of an inner harbour for a steam tug and other port craft.

198. (*Sir John Coode.*) Can you tell us at all approximately what would be the proportion of trade carried on in sailing ships as compared with steamers before the prohibition?—It is very small.

199. A very small proportion?—Yes; they are almost extinct. There are very few sailing vessels now chartered from England to India. At times there will be a considerable number of three-masted vessels lying in the roads at anchor. I make inquiries what they are, and I find they are all local craft belonging to native owners, just coasting craft. They are just kept afloat until they are completely rotten, and then their trade is transferred to the British India steamers.

200. (*Admiral Sir George Nares.*) Then in fact the harbour merely affords trading accommodation and shelter?—That is all.

201. It is not to be looked upon in any way as a harbour of refuge?—No.

202. And on the springing up of a cyclone vessels must get out of it as quick as they can?—I do not say that they must, but they had better do so for safety.

203. What is to become of those that cannot get to sea?—They should not be there.

204. (*Sir John Coode.*) Suppose they are there?—Supposing they are there, they must take their chance. My own opinion is that they have a very good chance of riding it out. They have a better chance of riding it out inside the harbour than they would have at anchor outside, I think.

205. (*Admiral Sir George Nares.*) Are the small ballasting vessels hauled up on the beach, or do they ride out the gale at moorings?—You mean the cargo boats.

206. I mean the cargo boats?—The idea is that they are hauled up on the beach if there is any threatening of bad weather. As a matter of fact many of them do remain at anchor, and if there comes a sudden cyclone there is considerable loss amongst them.

207. Why do the vessels go to sea? Is it because of the sea breaking in over the top of the breakwaters, and disturbing the water, or is it really that they are afraid of not being able to ride it out from the strength of the wind?—I should say that it is the wind more than the sea that will be the danger to them when the harbour is completed, and that that was the danger when it was complete, but at present you see it is a very confused sea that gets into the harbour.

208. How does the sea get in, does it get through the entrance, and also over the top of the breakwater?—Yes, through the entrance, and also over the top of the breakwater.

209. Then the confused state of the sea inside the harbour, does not all depend upon the position of the entrance?—Certainly not at present. Wherever the entrance might be in the present state of the outer arms, the sea would be confused.

210. Then, wherever the entrance is placed, there will still be a considerably disturbed sea inside in a cyclone, will there not?—That is rather begging the question.

211. The vessels will have to go to sea?—That again is a little begging the question, I think. Captain Taylor maintains that the north-east entrance would just make the difference to its being safe or otherwise for a vessel to remain in the harbour during a cyclone. Captain Taylor is an authority, but I must say that I am not quite prepared to accept that conclusion myself.

(*After a short adjournment.*)

Since the Committee adjourned for luncheon I have obtained and brought here the last authoritative marine chart. That was made in 1876.

212. (*Sir John Coode.*) Before the works commenced, do you mean?—As the works were commencing.

213. That will be very valuable?—I thought it would be useful in regard to these currents especially. I have a note here about them: "During the survey "there was generally a current setting to the north-"ward, varying from one half to one and a half knots "an hour, but towards the end of October the general "northerly direction was not so decided, and the "strength was very variable. On one or two occasions "after several days, during which hardly any littoral "current was perceptible, and when a tidal motion "was detected, there was suddenly a strong set to the "northward. On these occasions the surf was higher "and the sand much disturbed, discolouring the water "to a depth of four fathoms. It was then very visible "that a large quantity of sand was in suspension, and "was being carried along by the current. The tidal "motion was apparent only when the littoral current "to the northward had ceased, the flood setting to the "north and the ebb to the south; thus, during the "S.W. monsoon, when the current sets to the north-"ward, it is strongest during the flood, and weakest "during the ebb. In the N.E. monsoon, when the "current sets to the southward, the reverse occurs. "The tidal motion is, however, small." Then as to the soundings there is this note: "The soundings are "reduced to low water ordinary spring tides, i.e., "7 feet 11½ inches below the Havilland's beach mark "under the north gate of Fort St. George; 18 feet 7½ "inches below upper edge of flooring on outside of T "head of pier; 16 feet 10½ inches below upper edge of "lower block in foundation stone laid by H.R.H. the "Prince of Wales; and 1 foot 1½ inches below De "Havilland's M.S.L."

H.W. F. and C., 8 h. 35 m. { Springs rise 3 ft. 7 in. / Neaps rise 2 ft. 4½ in. / Neaps range 1 ft. 4½ in.

This is a chart of the "Madras Roadstead, surveyed "by Navigating-Lieutenant F. W. Jarrad, R.N., "Deputy Superintendent, assisted by Mr. P. J. Palle, "Assistant Superintendent, Marine Survey of India, "October, 1876." Now I should just tell you about these soundings. There is no doubt they are very correct as soundings, but we were never able quite satisfactorily to identify the datum, so that if you

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compare them with our more recent surveys I know that there is a little difference. I forget what it is now, but we have never used this as a chart for comparison of depths. We have always used our own.

214. He gives a bench mark here, but you could not find it?—I cannot remember at this moment what it was, but there was some difficulty in transferring it. We consulted these officers themselves, and they could not give it.

215. He gives 7 feet 11½ inches below a bench mark?—So he does; it could not be identified for some reason, but our own surveys, of course, all refer to the same datum, so that for changes of depth I must ask you to take our surveys.

216. But you do not know what your datum is in relation to his?—No, not quite. *This* is 1876. We have a very excellent survey of 1879, and I have brought you now a plan which I had not with me this morning.

217. (*Chairman.*) Our question now is, you see, as to the position of the entrance?—I was obliged only to give you the general result of this, because I had not got this with me before, but this shows how very little change there was between 1879 and 1882, notwithstanding the great storm of 1881. There is nothing like the deposit there that there is on the chart of 1886.

218. *This* is the deposit you refer to?—The lines are 1882, and the red figures 1879.

219. That is proving the receding of the sand?—Yes; this shows that outside six fathoms there really was no change, notwithstanding the heavy storms that we had in the interval. Then the comparison of this last survey of 1886 shows a little change there, where previously there had been none.

220. I see that this chart which you have produced of the comparative depths in 1879 to 1882, rather points to the sand silting up in the inside of the wall on both sides?—Yes, it is very very slight. I think the last soundings will have been taken on the rubble base. Then just to continue what we were speaking of before, I have brought with me here the two lines that were wanting in the previous plan. 1884 is the last mark, and here is 1885, and 1886. Then 1887 goes back again nearly to the position of 1885. I have it here, but it is only laid down in pencil.

221. Will you tell us what is the state of the harbour at present. What is the depth of water at low water on the part that was destroyed?—It varies a good deal. These marks that you see here are blocks which are still standing above water.

222. At the original height above water?—Yes, they have settled something, perhaps a foot or 18 inches, or something of that sort, but they are standing. *Here* there are a few standing and so on, and between them, generally speaking, there is only one place, I think, and that is somewhere about here (*pointing to the plan*), where the second of the four courses has been removed. The two top courses for perhaps the greater part of the length are gone, but for a considerable part of the length also (I cannot quite tell you now how much) only one course has gone, leaving the depth over the standing work, we will say, four feet. With the exception of where it is shown there (*pointing to a section*) the whole of that is gone, that is, two blocks. That block is gone, I think, with little exception the whole length of the harbour side. Of the sea side, roughly speaking, one half would be remaining and one half gone. The two lower courses, as far as we can tell, are untouched.

223. As far as you can tell?—Yes, it is impossible to say positively that there may not be some movement. It is only the diver's account that we have as to that, but the diver has walked all along *here* and he says, so far as he can see, there is no change from what it was when originally set.

224. And what has been the effect upon the rubble base?—Supposing *this* to be the sea side, the rubble base has gone like *that*.

225. Do you call *that* "dispersed"?—Well, drawn down by the action of the sea.

226. By the action of the retreating sea?—Yes, and in certain cases just in the curves it has been undermined, and that wall has fallen over.

227. (*Admiral Sir George Nares.*) To seaward?—To seaward, and in all other cases all along the straight portion *here* and *there*; whatever has gone has gone over into the harbour.

228. (*Chairman.*) What is the greatest distance to which any of the blocks from the two upper courses that have been thrown down have been carried into the harbour?—There are one or two cases of a most extraordinary kind. This has come to my knowledge since Sir John Hawkshawe's committee sat, just about here (*pointing to the plan*). There are eight blocks lying close together, just as they were originally set in the work, and at a distance of either 60 or 72 feet from the place at which they were placed. They must have leaped bodily over that distance, without ever touching the ground, because there they are in the same relative position. If they came from the sea wall there are 72 feet, if they came from the harbour wall there are 60 feet. I maintain they must have come from the sea wall.

229. That is on the north-east angle?—No; half-way out. There are other cases, but not quite so many along *here*.

230. At a distance of from 60 to 70 feet?—Yes.

231. (*Sir John Coode.*) Whether they leaped or were carried along gradually is not very material; there they are. Do you think they would have been carried there?—They must have been; there they were in the same relative position as when they were set in the wall. If you take half a dozen books in your hand and chuck them over there, they might fall on to the floor in the position in which you threw them, but if they struck the table on the way they would be all spread about.

232. Have they gone over in a lump then?—Over in a lump; all packed close together, like books on a shelf.

233. With the joints fitting as close as they were when set in the work?—Yes.

234. Is that the two courses of blocks?—No; only one course. I mention this just as an illustration to make clear what it is that has happened. The harbour wall went first—we always found that it did—then the force struck the sea wall and carried these blocks, in one bound, 60 or 70 feet—blocks 12 feet wide and eight feet deep without separating them.

235. (*Chairman.*) That is quite clear of the rubble base?—Clear of the rubble base. They are lying just at the foot of the rubble base.

236. So that they may have rolled down?—No; I say they could not have rolled down, because they are there, fitting close together. A roll would have disturbed them.

237. (*Sir John Coode.*) How many of them are there in one mass?—The e were eight, I think. I think it is a very important fact.

238. (*Chairman.*) I think you have entertained the idea of a north-east entrance?—Generally; it was discussed with other plans.

239. But I understand you still prefer retaining the entrance where it is at present?—I must reply to that with a qualification or rather an explanation; I do personally prefer it.

240. I think, if you please, I should like your opinion unqualified by anybody else's?—I mean to say that the east entrance has not been sanctioned upon my advice, it was originally settled upon the advice of Sir John Hawkshaw's Committee.

241-4. (*Chairman.*) I will put my question in another form. You propose to keep the entrance where it is now, combined with a boat harbour in the sand to the southward?—Yes, a boat harbour at least, and I have since developed that idea into a more extensive scheme.

245. Well, giving a harbour that will take steam tugs and so on?—Yes, and even more than that.

246. But looking upon the entrance to the north-east as an alternative scheme, to which do you give the preference?—I give the preference to the east.

247. Putting out of the question that harbour in the sand for the present, what would be your opinion as to the best place for the entrance?—I think the eastern entrance is easier of access, and it is easier of exit than the other.

248. Would you retain it at its present width or reduce it?—I would reduce it to 450 feet. I accept unreservedly the recommendations that were made by the committee.

249. (*Sir John Coode.*) The Hawkshaw Committee you mean?—Yes, I entirely agree with them, personally, but it stands upon their authority and not on mine. If

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I had not agreed with them I should not have consented to go on with the work.

250. Then I understand you prefer the present entrance to one to the north-east?—Yes, I prefer it, but there is another argument.

251. Supposing the Government were seriously contemplating making an entrance on the north-east, and were to ask your view upon it, what would you say with regard to it?—I should rather prefer to say, that looking at the merits of a north-east entrance and an eastern entrance, and all other matters being the same, that it is a nautical question, and I would rather be guided by nautical authorities, but when it comes to an engineering question, I think the enormous expense of making a north-east entrance must be taken into account.

252. Then the question would resolve itself into this, whether the game is worth the candle?—You see the little scheme that I have drawn out *there*, which I have never produced yet officially; that would cost about 50 per cent. more than making a north-east entrance, and for the same money as a north-east entrance I will tell you what you would get. You would get *those* two jetties.

253. When you say those two jetties, you mean the two enclosing jetties?—Yes.

254–5. You had better say two enclosing jetties in the south-west angle of the harbour, then the notes will be intelligible?—Yes, one being on the 4½ fathom line, I think, and the other running out from the shore to meet it.

256–8. Leaving an entrance between the two of how much?—Of 200 feet. The cost of making that north-east entrance, as designed by the Madras Committee, would be 13 lacs of rupees; those two jetties would together cost 4½ lacs. That would give the best harbour, but only with the existing depth of water. To dredge a channel diagonally through that boat harbour as I have shown, including the cost of the dredging, would bring the total expense up to 7½ lacs.

259. (*Chairman.*) That is half the other amount you have quoted; 14 lacs you quoted for the north-east entrance, did you not?—Thirteen lacs for the north-east entrance. Then for 7½ lacs I get that boat harbour dredged out to 4½ fathoms as far as the south pier.

260. (*Sir John Coode.*) You do not want a boat harbour of 4½ fathoms?—No, I am going a bit further. In order to make this ship dock to the southward of the south pier to the area shown, it would be in round numbers, say, 14 lacs, that is a little more than a north-east entrance. That would provide all that deep water in here (*pointing to the plan*).

261. Does that include the screw pile wharf?—No. Then the screw pile wharf would be another five lacs. That is 1,200 feet long, that would take three large steamers.

262. That makes a total of, say, in round numbers, 19 lacs.

263. (*Chairman.*) Have you ever submitted a proposal for a north-east entrance?—No, never. I have considered proposals. I considered them when the plan was originally suggested in 1873. That plan was then considered among others, but nothing very definite came of it.

264. But you have not done so since the destruction of the harbour, have you?—No, I have always been of opinion that the matter should be allowed to stand over until we had more nearly completed the existing design, in order that there might be more experience of it.

265. (*Sir John Coode.*) Has not that time now arrived?—No.

266. I understand you are out nearly to the end of *this*?—Yes, but I believe if we had a cut through *there*, we should really do it better by building over the site, because we should be able to bring our cranes to work upon it, and picking up the blocks that had been set is a comparatively small matter. I should propose to dispense with the wave-breaker for that distance and take the risk of that.

267. That would be dispensing with the wave breaker at a critical part of the work; it is a part that has been destroyed?—Yes, that is true; at the same time it would be for a very short time, because directly I got over *there* and got into the straight outside, I should come back and build an overlapping arm so as to bring it into shelter. Still the way of doing it is a matter of minor importance.

268. (*Chairman.*) Do you consider that in closing up that entrance and opening one to the north-east with a protecting arm, that the sea face would be exposed to greater risk of damage by being unbroken than at present?—No, I do not think so.

269. You do not think that the entrance there in the centre of the work acts to a certain extent as an escape valve for relief?—No, it has never struck me so at all, I confess.

270. (*Sir John Coode.*) Then if I understand you rightly, you would build out from the shore and reconstruct?—And reconstruct that, but stopping short of those special works for the pier heads and then turn the titan round.

271. Backhanded, you mean?—Yes, backhanded.

272. Then when the time arrived for closing the east entrance you would close that up in a similar way, from the south pier, if I understand you rightly?—Yes, I should carry out the overlapping first. Then when that was completed, and the two piers carried as far as you could——

273. The two present piers?—The two present piers carried as far as you could carry them; then I would pick up the blocks that have been set *here*, and at the same time pick up as much as possible of the rubble base by means of the cranes, and as soon as that was completely opened then I would build across the present entrance. That seems to me the most practical way of doing it, but I am bound to say that engineers are not allowed to say that anything is impracticable, but that comes nearer to it than anything I have ever heard yet.

274. It is a question of cost, is it not?—It is a question of cost; everything is that.

275. It is, so to speak, an ugly job to undertake there is no doubt whatever, but it is simply a question of time and money?—It is that.

276. And one which is not very easy to estimate?—I should be very sorry to do so.

277. (*Chairman.*) You mean that the clearing the north-east entrance of the material which has been placed there, would be a very difficult matter?—Yes, and all the more difficult from the materials having been dispersed by the sea. If we set to work to pull them up as they were built, we could have done it much more easily than we could do it now.

278. That has been estimated, has it not?—I do not know that it has been a matter of estimate, but we know exactly how to set to work at the picking up of built work, while the other has to be considered; and I may just mention this to show the peculiar difficulties of this place, that it is absolutely impracticable to make use of a floating base for it. There are not many days in the year on which we really could bring a big pontoon or anything of that kind over the work to pick up materials, and we should be liable at any time with a cyclone to have this pontoon destroyed.

279. (*Sir John Coode.*) But you know it is possible to blow up these blocks by dynamite, do you not?—I am not so much afraid of the blocks as of the interminable time that is taken in removing the rubble.

280. (*Admiral Sir George Nares.*) Would you place the rubble base in the north-east?—The rubble base is there already.

281. I understood that that rubble base was to be increased in width?—It has been increased in width. The whole of that proposed entrance is now completed as far as the rubble base is concerned.

282. (*Sir John Coode.*) That has been done, has it not?—That has been done.

283. I thought you had simply arrived at the end of the straight arm?—No, the way in which we interpreted the orders given in the Secretary of State's despatch was, that unless the question was re-opened before we arrived at the point at which we should have to proceed upon the site of the proposed entrance, that question must be considered closed.

284. That is what we have here as Lord Cross's view?—No, that was the order given in 1884, at least three years ago, by Lord Kimberley. Now I must tell you when we did arrive at that point, Mr. Thorowgood applied personally to Mr. Grant Duff (as he was then) and told him that the question must now be considered and settled one way or the other, and asked him whether he was aware of any impediment to our going forward on the assumption that the question of the north-east entrance would not be brought up again. Mr. Grant Duff replied that he knew of no intention anywhere of the question being re-opened and that we might safely go ahead.

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285. Does that appear anywhere in writing in any form?—No, it does not appear in writing. It was not considered necessary to put it into writing. Mr. Grant Duff himself had been an advocate for the north-east entrance, and if anything had been likely to be done, it would have been sure to have come to him.

286. (*Chairman.*) Is there anything before us now to show who suggested the north-east entrance?—Yes. The Madras Committee's report.

287. Can you point out on this plan how far the works are advanced?—That rubble base is practically complete. You will observe that there is a little change that complicates it to some extent. That blue line on the Madras Committee's plan is intended to follow the old line of the pier, but we have since altered that, and we are building a new line of pier inside. This blue line would be something like that (*describing*). but now it would have to be there, just bringing it a little nearer in shore. Now you can see from that that we are getting very close to it. The idea is to make that 500 feet, in fact, we have two-thirds built across it.

288. You have not only two-thirds built across it, but you have increased the rubble the whole way across?—Yes, we have increased the rubble base the whole way across. Now, I had an alternative scheme for building that which would have saved a good deal of this, but when we were assured the question was not going to be re-opened, it was dropped. It is a very simple matter to take that work up again, and use the blocks elsewhere.

289. It strikes me that that is the simplest part of it. What is the depth of water over it?—About 23 or 24 feet over the rubble base. Some of the top rubble must be taken off, but if it were lowered 12 feet, I suppose it would be enough.

290. Can you tell me how far the restoration has been carried out on the other side. The rubble has all been deposited *here*?—Yes.

291. (*Sir John Coode.*) To about the same extent as on the north, practically, is it not?—It is practically the same thing.

292. (*Chairman.*) I think we may take it that although the rubble is the easiest to deposit, it is the hardest to take up?—I am not quite sure about that. With regard to the blocks, if there is any difficulty you can always reduce them to rubble by a charge of dynamite, and the rubble can be picked up. It is simply a matter of time and labour. My idea was rather with regard to the large blocks in the wave breaker, because there the number would be so great that it would be really a very serious matter to sacrifice all those. It would be also an extremely dangerous thing to blow them to pieces with dynamite.

293. (*Sir John Coode.*) As you have gone on, I understand you have put down a wave breaker, so that wherever we see this red tint on the chart both wall and wave breakers are complete?—That bit of wave breaker (*pointing to the plan*) has not been put down, but from the last letters I got, which are dated before there was any idea of this Committee, they were going to do that in the month of April, but I imagine that that has been stopped. This is the 31st March. The wave breaker is completed up to here (*pointing to the plan*). I will not say that the works are stopped, but that they are stopped so much as is necessary. That order was given without reference to me, and they will have to carry it out at their own discretion at Madras.

294. What we want to find out is are they going on or not at this moment?—A telegram has been sent out there to suspend the works so far as may be necessary for keeping this question open. That, I believe, was done, but in what way they have interpreted it I do not know.

295. Must not that mean stopping everything, except block making?—I presume it would at the north pier. They would not go on at the north pier, certainly, but I know that Mr. Thorowgood does not like leaving that wall without the wave breaker.

296. (*Chairman.*) Can you give us any idea of the time that it would take to clear the position of the north-east entrance?—I should be very sorry to pledge myself to any time. It would be a most tedious job.

297. Is there any other difficulty that you can suggest to us with regard to opening a north-east entrance?—I take it you mean with regard to the engineering view, that is, the execution of the works. Beyond that I would rather not give an opinion. I tell you my own conclusion is that it is inferior to the other for nautical purposes. But you are much better able to judge of that than I am.

298. From an engineering point of view, do you think that there is possibility, in the case of Madras being visited by a cyclone again, of the entrance being interfered with by the protecting arm being thrown into the entrance?—I do not think that there is any fear of the entrance being obstructed, because if it is 500 feet wide, which is what is proposed even if you are to imagine the 72 feet leap to be repeated, it would still leave more than 400 feet; but if that overhanging arm were washed away, as *this* has been, it would leave that entrance then fully exposed, and the overhanging arm would be worse than useless. It would throw a confused sea in there instead of its being a shelter.

299. (*Sir John Coode.*) But it must be assumed that if that overhanging arm is to be constructed, it must be executed in such a way as that it shall not be disturbed?—Quite so; that you must assume every-where.

300. It means, of course, a considerable expenditure upon that arm in order to render it invulnerable, if it is to be done, does it not?—Yes. That rubble base was deposited 12 or 18 months ago.

301. What is the depth of water over that?—About 24 feet. It is hardly as much as that.

302. (*Admiral Sir George Nares.*) Do you adopt the estimate of the Madras Committee of 13 lacs of rupees?—That is a calculation of my own based upon the prices given in the Madras Committee's detailed estimate.

303. (*Sir John Coode.*) Do you mean the Madras Committee or the Hawkshaw Committee?—The Madras Committee. The Hawkshaw Committee did the same, and came, I think, to very nearly the same sum.

304. 127,000*l.* and some odd?—Yes, it was done the same way, but I think the members of the Committee thought, and certainly it is my own impression, that the price for removing the rubble was put rather low. I should not like to pledge myself to that estimate for doing the work.

305. Then the case is different now from what it was then?—Yes, there is 50 per cent. more of the rubble, or about that.

306. And of blocks, about how much?—All the new blocks that are put at present are only built blocks, and it is not a very serious matter to take them up.

307. (*Admiral Sir George Nares.*) Do you adopt the engineering design and the section?—No; I should carry out the same section as we are proposing for this work, that is to say, the work that is now going on.

308. Would that increase the expense?—No, it would be about the same.

309. Do you approve of the engineering design and of the section, because if you do not, these 13 lacs are all moonshine?—I am bound to say that I do not approve of the plan there. I do not approve of that way of carrying it out.

310. You do not adopt it?—If I were asked to design a north-east entrance it would not be like that.

311. (*Sir John Coode.*) Will you explain to us what it would be?—I say this under correction, because what I want to meet is the nautical difficulty. My idea would be that instead of allowing the overlapping arm to come 300 feet beyond the line of the pier, it ought to come something like 1,000 feet, so as to give a ship room to recover herself after getting under the lee of the pier; then I am very much inclined to think, though I cannot say that I have quite matured it, instead of making the entrance *here*, I should prefer to make it *here* (*pointing to the plan*).

312. Further in?—Further in, so as to give the ship more room.

313. How would it be as regards depth?—I think there is plenty of depth,—6 fathoms. That is my idea; but I confess that it is rather crude at present.

314. (*Admiral Sir George Nares.*) I understand that the dredger to pick up the rubble would have to work with the present entrance on the eastern side open?—The present entrance must be kept open until the new entrance is made, that is very clear.

315. And the dredger will, in fact, have to work in a sea-way inside the harbour, and be subject to being caught?—You are rather assuming a dredger. Whatever craft is wanted.

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316. Whatever is wanted, put it in that way?—Yes.

317. (*Sir John Coode.*) You would not do it with a dredger, would you?—No.

318. (*Admiral Sir George Nares.*) I understand that it would be as expensive now to alter from the eastern entrance, as it would be if the harbour were completed as designed, and then you opened a north-east entrance?—Yes, with some exception as to the completion. It shows it better upon my plan. You see there are certain special works near the pier heads which would be unnecessary if the present entrance were closed. I should stop short, say, *here* (*pointing to the plan*), and then if the matter was to be reconsidered, we would reconsider it when the work is complete to there.

319. (*Sir John Coode.*) Do you mean to say that you would go on with the restoration of the works out nearly to the eastern entrance?—I think I should; certainly if this idea turned out to be practicable, of moving it inwards a bit, I would undoubtedly do so; but if this idea were favoured of making it on the site of the Madras Committee's recommendation then there is the question of all those wave-breaker blocks to be considered.

320. Still you would not then require the special wave-breaker blocks at the present entrance, it would be merely transferring the special wave-breaker blocks from the present entrance to the new entrance, would it not?—Yes; then it is a question of laying down these wave-breaker blocks and taking them up again, which I look upon as the greatest difficulty. If the Government would accept the responsibility of leaving that piece unprotected until we got the return to protect it, and not put down the wave-breaker blocks, I believe that that would be the best way of getting over the difficulty.

321. (*Admiral Sir George Nares.*) And the difference of expense would be very little, would it not? You would save the expense of making your mound in the present entrance?—No. If that entrance is to be closed the mound must be made, any way.

322. My question is now, if the harbour is completed as originally proposed, without this mound *here*, and, after that, opened to the north-east end, there would be very little more expense in changing the entrance in that way than if we were to come to the conclusion that we had better change it at once, now that the rubble mound is completed?—I think that the present design might be brought very much nearer to completion; in fact, brought pretty nearly to completion.

323. Without any loss of money?—Without any loss of money.

324. That alters the question altogether.—It would require some little consideration as to how to do it. If it were said that a north-east entrance would have to be made ultimately, I should very carefully consider what portions of the work I could suppress; but I should push forward *those* two piers to the greatest extent practicable as the first thing, and get the shelter for the harbour in its present form as soon as possible. Then I think it would be quite time enough to consider what we should do in the way of making a north-east entrance.

325. (*Sir John Coode.*) Will you further consider that, and give us you views upon the point in a more definite shape a little further on?—Yes.

326. I understood from what you said just now that you would like to consider the matter?—There are some matters of detail that I should like to consider.

327. I think it would be well for you to do that.—Certainly.

328. (*Admiral Sir George Nares.*) So that in your opinion the eastern arm should be built before the north-east entrance is open?—That must be done. To be sure it is not necessary to build that, but I think it should be built.

329. (*Sir John Coode.*) I think it would be well for you to consider that, and let me have the result further on, when you have matured the thing. Of course we must look at the thing from every point of view?—Yes. I should very much like to have some nautical guide about the question of making the entrance close to the outer arm of the pier or nearer shore.

330. (*Admiral Sir George Nares.*) That would be the same wherever the entrance was?—It would immensely simplify the making of the entrance if it were brought nearer shore.

331. (*Sir John Coode.*) That would be a matter for consideration if it were decided to recommend a north-east entrance at all?—Yes.

332. Again with regard to the question of this arm, you said just now you would like to see this not less than 1,000 feet. Granted it was 1,000 feet, you would shelter the entrance to a very great extent, but while you did that, would not you render a vessel entering or leaving much more liable to be carried down on a lee shore?—My idea was not so much to give better shelter to the entrance, because it appears to me that that really gives enough.

333. Then why would you carry it 1,000 feet if it was not to give more shelter?—Simply to allow a ship to recover herself on coming round the pier head. I am speaking in ignorance now of nautical matters; but as I take it the real difficulty of that position is this: let us take a 400 feet ship; I imagine that when the ship 400 feet long is in that position with half her length abreast of the pier head, she is completely the sport of the waves; if the crest of the wave takes her after part it must send her in one direction; if the hollow of the wave takes her it must send her in the other direction. Is not that the case?

334. (*Chairman.*) Yes, I think it is a very awkward predicament for a ship to be placed in?—If instead of 500 feet, you were to take 1,000, that would be better, I think.

335. (*Sir John Coode.*) Your opening remaining the same, suppose *that* to be 500 feet, and a vessel has to make all *this* distance, is not she more liable to be carried down on a lee shore if she has all this distance to traverse?—She is a long way from the lee shore. That is 1,000 feet from *there* (*pointing to the plan*). I confess I have never put this down on paper. I think if that were made so, a vessel coming in *here* would have much more space to recover herself before she had to get in between *those* two points, than she would have if it was *here*; if it was *there* (*pointing to the plan*) why she would still have more room. What would you like me to do about this?

336. (*Admiral Sir George Nares.*) We might have the expense of altering now and altering after the works were completed, might we not?—Yes.

337. (*Chairman.*) Even now you say the estimate does not cover the increased expense that has been incurred by depositing 50 per cent. more rubble?—No, that would have to be added.

338. (*Sir John Coode.*) More rubble and more wave breaker?—Yes.

339. What we should like to have would be the revised estimate for making an eastern entrance under present conditions, which are materially changed from what they were. At the same time, if you prefer to put your views with regard to a north-east opening in writing, you might do so.—I am basing my observation solely upon my ides of nautical grounds. That appeared to me to be the great difficulty of a ship. I wanted to avoid that and give such an entrance as would avoid it, but of course, as regards any suggestion of that kind that I make, you understand the matter much better than I do.

340. (*Chairman.*) Quite so, but it is not our opinion that we have to act upon. We have to collect the opinions of the men who have to handle the ships amongst others?—I should like to confine my opinion to the engineering points.

341. In consequence of that angle being exposed to the extreme force of the north-east wind and sea, would that include a covering arm?—I will tell you what I had better do. I had better give you what the cost per foot run of that covering arm would be.

342. (*Admiral Sir George Nares.*) And also without the covering arm, because the covering arm will come whether or no, if it comes in there according to its length, but the thing is to get it out to *there* (*pointing to the plan*). The covering arm is an extreme which will be equal, whether put there now, or in five years time, as you say, at so much a foot.—I will give you the expense now of completing *this* and removing it, and the cost per foot run of the covering arm.

343. (*Sir John Coode.*) What we want is the difference, if any, between doing it now and doing it hereafter, if the work is complete according to the Hawkshaw Committee's recommendation. Will you supply us with that?—Yes; the difference in cost, if any.

Adjourned to to-morrow at 11.30 o'clock.

At the Board of Trade, Whitehall.

Wednesday, 27th April 1887.

MEMBERS PRESENT:

VICE-ADMIRAL SIR NOWELL SALMON, V.C., K.C.B., in the Chair.

SIR JOHN COODE, K.C.M.G.

REAR-ADMIRAL SIR GEORGE S. NARES, K.C.B.

MR. F. C. THOMPSON [India Office], *Secretary*.

Captain G. N. HECTOR examined.

Capt. G. N. Hector.

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344. (*Chairman.*) Will you be good enough to state to the Committee the name of the ship of which you are now in command?—I am in command of the "Carthage" at present.

345. (*Sir John Coode.*) Are you the senior captain of the fleet of the Peninsular and Oriental Company?—I am senior but one. The captain of the "Rome" is the senior.

346. (*Chairman.*) But you have been commanding vessels of the Peninsular and Oriental Company for some years past, have you not?—Yes, the last 23 years.

347. Vessels calling regularly at Madras?—Calling at nearly all the Indian ports.

348. Have you been in the habit of calling at Madras?—I have not had any very great experience of the Madras roads. I have been there occasionally.

349. Will you please tell us at what times you have been there?—The last time I was there was four years ago.

350. Were you there during the construction of the harbour?—No, the harbour had been constructed during the time I had been absent, at least, it had been constructed between the last time I was there and the time I was there before.

351. Were you there when the harbour was complete?—Yes, except where portions of the wall had been washed away.

352. I mean while it was complete, and before it was destroyed?—No, but only a small part of the seaward portion of the wall had been washed away when I was there.

353. (*Sir John Coode.*) Of both arms do you mean?—There was a slight portion of the southern arm gone, I think, but the principal damage that was done had been to the sea wall—the sea front.

354. Of the northern arm?—Yes, of the northern arm, speaking of the entrance as the dividing point.

355. (*Chairman.*) Were you there in 1881 at all?—No, I was there in September 1883.

356. Then you had no experience of the harbour when it was at its best?—No, except that there was not much damage done to it when I was there. This (*pointing to the plan*) had been washed away. For all practical purposes the harbour was intact when I was there last. I took my ship to the entrance.

357. You think the effects of the cyclone of November 1881 were not sufficient to render the harbour insecure under ordinary circumstances?—No. It was quite secure for ordinary winds when I was there. In fact, it was blowing very freshly when I was in there. The blocks on the seaward front were awash. I have heard that it has been further damaged since then. I do not know whether it is so or not.

358. During the time that you were there, since the damage done to the harbour works, have you seen the sea break over the ruins to any great extent?—The swell or the rollers were breaking over slightly during the time that I was there; at least, the water was just falling over them, striking the walls, and leaking over.

359. You are speaking of the easterly swell, and not of the surface sea produced by the prevailing wind, are you not?—No, I am speaking of the swell only. The swell that was rolling in against the breakwater.

360. (*Sir John Coode.*) How long were you at Madras?—I was there for about 24 hours. I entered the harbour in the early morning. I was there twice.

361. In what part?—Just in here (*pointing to the plan*).

362. "Here" we shall hardly understand. You mean a short distance within the harbour entrance, and rather to the south of the centre line?—Rather to the south of the centre line, exactly, on each occasion. I was in the harbour twice, once going up, and once coming back again.

363. (*Chairman.*) That was during the south-west monsoon?—That was during the south-west monsoon.

364. Therefore you anchored on the south side of the harbour?—We anchored here (*pointing to the plan*). There were other vessels lying over *there* at the same time. There were two vessels *there*, one *here*, and one *here*, and a vessel astern of us.

365. Were those two vessels lying on the north side affected by the swell?—No, hardly at all. It was perfectly smooth; at least, there was no swell. There was nothing that would cause a boat to move much alongside the ship, except that when the wind came off in gusts from the shore, it would be a little difficult to keep the boats on the weather side sometimes.

366. What month was that in?—I was there in September.

367. Did you take your own ship in?—I took her to the entrance, and the pilot boarded me just outside the buoys. There was no difficulty in taking the vessel in.

368. Was she affected at all by the current?—No, not the least in going in. I had no difficulty either in going in or in coming out.

369. Was the water smooth or rough?—The water was fairly smooth. There was a considerable roll on at the time; the breakers were breaking very heavily, as they always do along the shore line, at least at that time of the year. When I went out there was a strong breeze blowing, but we hove our anchor up and held on by our stern line. Then, when we were ready, we let go the stern line and went out.

370. (*Admiral Sir George Nares.*) Was it breaking inside at the same time?—No, there was no break inside.

371. (*Sir John Coode.*) Then the sea outside was very moderate, I understand?—The sea was moderate; just an ordinary sea in a south-west monsoon. The rollers were rather heavier than they frequently are during the south-west monsoon.

372. Did the disturbance of the rollers extend well down into the harbour?—No. There was just a little off the mouth of the harbour, but nothing to speak of; nothing to affect the ships in any way.

373. (*Chairman.*) And the seas at that time were just breaking on the summits of the ruins?—They were breaking on the summit of the ruins. Where the wall was perfect the water was not coming over at all, so far as I remember.

374. Have you formed any opinion about the position of the entrance?—Yes, I think so. I discussed the matter very freely, when I was there, with many people who were there, and I had a good look at it myself during the time.

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375. Do you consider that the entrance is in the best position?—I think, looking at it from every point of view, it is.

376. I mean to say from a seaman's point of view?—From a seaman's point of view. I will not attempt to discuss it from any other, because I really do not know what the physical difficulties connected with it are. I am speaking now simply with reference to handling ships, taking them in and taking them out and looking to their safety, both going in and coming out.

377. Have you had any experience of typhoons on that coast?—No, not on that coast, but I have had very considerable experience in typhoons at various times during the last 20 years. I have never had a typhoon in the Bay of Bengal. I have had some very bad weather, but nothing approaching a cyclone there.

378. From what you know of Madras harbour, should you feel inclined to trust to the shelter given by it if a typhoon were coming on?—Certainly not. Nothing would induce me to remain in the harbour with a typhoon blowing—that is, of course, if I could get out.

379. Do you think that any difference in the position of the mouth of the harbour would so alter the conditions of shelter, as at present given, that it would be safe to lie there in a typhoon? I mean to say, supposing that the eastern entrance were closed up, and an entrance opened at the north-east corner, would that affect your opinion?—If I could possibly get out I should go out. I would not stop in the harbour in a typhoon. I do not think any prudent man with a large ship would ever think of remaining there under such circumstances. So far as I am able to judge from having been there and from all that I have heard, I think the entrance is in the right place for handling ships. If you get your ship in here (*pointing to the plan*), and you get her broadside on to the rollers, you have very little room to manœuvre in. You would have to cross the bows of vessels lying there, and you would have considerable difficulty first in getting in and then in getting out.

380. (*Sir John Coode.*) How does the reply you have just given us agree with the opinion which has been sent to us in writing as that which you gave in September 1883. In that document I see it stated that you said this: "The proposed alteration of the entrance "from its present position to the north-east angle of "the northern arm commends itself to my judgment." Then you go on to state the advantages which you think would accrue from it. I suppose this was taken down from you, or is it a letter, or what?—I do not know. We had some conversation during the time I was there.

381. This is a note which professes to be from Captain Taylor, master attendant; it is one of a series of opinions we have had sent to us as a Committee, coming from Lieutenant Taylor, R.N.R., master attendant, in which he says: "I have the honour to forward, as "desired, the opinions of nautical men upon the closing "of the eastern entrance to the harbour"?—I do not remember that. If I have given that opinion I have altered it since. I may have given it.

382. Further reflection has induced you to alter that opinion?—We have had a good deal of discussion about this at one time and another.

383. This is four years ago practically, so that a man may very well modify his opinion in a matter like that in four years?—I may have had a conversation (and probably did) with Captain Taylor, because he was off at the ship, but I think if I did give that opinion then, that I am quite of a different opinion at present.

384. You are quite entitled to alter your view, especially on a subject of this kind.—It is a matter we have had under discussion amongst ourselves, though not lately, because I only received notice last night that you would wish to see me upon the matter.

385. (*Chairman.*) Will you look at that plan please (*handing a plan to the witness*)? There is a suggestion there for an entrance at the north-east corner, covered by a projecting arm?—Yes, I remember that that was discussed.

386. Will you please put yourself in the position of the captain of a ship in considering that suggestion. What is the length of the "Carthage"?—The length of the "Carthage" is 440 feet over all.

387. Will you please put yourself in the position of the captain of the "Carthage" with the north-east trade blowing, and the easterly rolling of the sea, such as you have experienced yourself, "taking" the harbour at *that* entrance; should you like that as an entrance?—No, I certainly should not like that as an entrance, because my ship would be, practically, much less under command than if I had an open entrance *here*, through which to come in. I might get my ship broadside on to the sea. I then have the chance, if anything goes wrong with the engines, of getting in nearer the shore than I should think would be prudent. In going into the harbour I should have to cross, probably, the bows of all other vessels that were at anchor there. Whatever other aspects the question may assume, for manœuvring the ships, I certainly think that the entrance in the centre of the sea wall is the safest entrance that we could have.

388. (*Sir John Coode.*) Both for entrance and for exit, would you say?—For exit, certainly. I do not think there can be any question about it for exit. I remember when I was there the question was discussed, and I suppose I must have given that opinion, which has been quoted, at the time, but it has passed from my mind entirely. The other question was as regards a proposed entrance here (*pointing to the plan*).

389. As was at one time talked of on the south-east knuckle?—The question was also discussed, as to silting. That I am unable to give any opinion about. I am speaking now simply of the handling of vessels.

390. (*Chairman.*) Supposing the entrance to be put at the north-east corner, do you think that that protecting arm, as it is called, would be an advantage, or a disadvantage?—That would be very questionable, I think. It would depend altogether upon the current, and what "set" you would get round *this* corner. I am hardly able to give any opinion upon that point. In some cases it might be an additional danger to a ship coming in. I think it is more than probable that is would be a danger. *Here* you see there is no danger. The only objection I can see to keeping this entrance open is, that it allows a little more sea to come in here, but then your prevailing winds are *here*.

391. (*Sir John Coode.*) When you say "here," kindly give the direction; is it north-east?—About north-east.

392. And south-east?—And south-east.

393. (*Admiral Sir George Nares.*) Southerly?—Yes, southerly.

394. (*Sir John Coode.*) North-east and southerly?—What I noticed when I was there was that the sea is likely to be broken by *this*; you would have a little jumble southward. I have not been in in the north-east monsoon, and I am unable to say what aspect the sea takes then.

395. (*Chairman.*) What would you say should be the narrowest width of this harbour, supposing the entrance to be retained where it now is; it is now 550 feet; that drawing, which you see before you, shows 450. Do you think that that would be sufficient?—I think so, because your ship is perfectly pointed before she enters. That is one of the great advantages, I think, with all these long ships, being able to get well out to sea to bring your ship in in a straight line. If you come in *here*, you have to manœuvre to bring your ship up, and she may fall off, or something may go wrong with the engines.

396. (*Sir John Coode.*) The entrance being retained there, this is, is it not, essentially a case where the narrowest possible entrance should be made in order to prevent the great disturbance which has been described to us as recurring occasionally along or near the shore?—Yes.

397. Not only in the harbour generally, but right up on to the shore?—Undoubtedly, an opening *here* would give less sea in the harbour.

398. Of that there can be no question.—But then you see there is very little space in which to handle a ship when once in there, and you want to get her into the best possible position in taking her in. I do not know what the exact length of this is (*pointing to the plan*), but the vessels take up nearly a third of the space. I know that was my experience in going in, when I had a good look at it all round.

399. Coming in at the present entrance a ship goes direct into her berth, whereas if an entrance were made from the north-east, she would have to take up her berth under the northern breakwater, and would have to make a very considerable turn, would she not?—You see your ship is immediately under shelter in here; all you have to do is to let the anchor go.

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400. If the entrance were made there, it would be the master attendant's business, of course, to keep the vessels in the harbour well clear of those that might be coming in?—I see considerable difficulties in managing the ships, if they have to cross one another, and especially these very long ships; they are not as handy as shorter vessels are.

401. Nor have they got good steerage way on them, have they?—No. In handling any of those big vessels you are obliged to keep a fair amount of steerage way upon them, otherwise you lose command entirely. You see, suppose you are coming in pretty fast here, as probably sometimes a vessel would have to do, you can immediately check her with the screw and let go your anchor.

402. That is through the present entrance?—That is through the present entrance. I am speaking now simply from the point of view of handling the ships. I can speak of nothing else.

403. That is precisely what we want?—Undoubtedly the work there would produce smoother water in a way and give greater facilities perhaps for working cargo by boats, but, on the other hand, it would not be nearly as safe to bring a ship in, nor could it be done as easily as bringing her in by the opening in the sea wall; at least, I think not. I really do not know what other people think about it. I have had one or two conversations with our own people. They are rather divided upon it, but as far as the men in the harbour are concerned, I think there are few who do not agree with me in thinking that the vessels would be more easily handled by being brought in at that opening, and with less danger.

404. (*Admiral Sir George Nares.*) In reducing the breadth of the entrance from 550 to 450 feet, would it be an advantage, do you think, in rebuilding the harbour, if this present entrance is retained, to wait a little for the results of experience after the blocks are placed before reducing the breadth, or so reduce it at once?—450 feet,—that is about the length of my ship,—that would be quite sufficient.

405. (*Sir John Coode.*) Do you think it might be narrower?—It is quite sufficient to take a ship in, because you see there is nothing to bring her up outside. You have only to steer straight; and handling these vessels, as we do in the canal, we see exactly how they can steer.

406. (*Admiral Sir George Nares.*) Then with that narrow entrance the water in the harbour will be considerably more tranquil than it has ever been, will it not?—I should think it would be. But then is it proposed to raise *this* wall much above the surface of the sea?

407. Yes, it is proposed to be six feet higher than before?—That will make all the difference in the harbour as to the smoothness.

408. (*Sir John Coode.*) On this plan it is shown 12 feet above high water; *that* (*pointing to the drawing*) is the wall as it was, and *that* is the wall as it is proposed to be?—That will make it much more secure.

409. In fact the north and south arms on the straight portion are at this moment raised to that level, as I understand from Mr. Parkes?—It seemed to me, from a superficial view of the walls generally, that they were inadequate to the work that was required of them. That, of course, is an engineering matter, on which I am not able to speak, but they look to me very slight.

410. And low?—And very low.

411. (*Admiral Sir George Nares.*) Do you happen to have taken any sounding just inside or just outside the entrance?—All outside the entrance. I was sounding off and on for about a couple of hours outside, because when I ran up to the walls at night there was no light or anything else to indicate where the breakwater was. I was quite close to the breakwater, and it was simply by the soundings that I kept away from it. I could not see it at night, and I was quite surprised in the morning to find how close I had been to it. I spoke to the master attendant about it when I went there. There was not a light of any description. With *this* wall, level with the water the night I went in, there was nothing at all to indicate where the breakwater was, and I heard the morning before I arrived there a vessel had steamed near it, and nearly got on it.

412. The Admiralty chart gives seven fathoms outside the harbour, does it not?—I almost forget; but I know I kept the vessel in about eight fathoms of water, and next morning I was quite close to the wall. I kept my ship just about *here*, and waited for daylight, not knowing where the breakwater was. I had a general idea. I knew I was outside of it, simply by the depth of water, and I spoke to the pilot about it, because I thought it such a very dangerous thing to leave a structure of that kind in eight fathoms of water without anything at all to guide one as to its position.

413. (*Sir John Coode.*) They have seven fathoms all round outside, have they not?—I believe they have been dredging the harbour very considerably lately. They have been using dredgers inside.

414. We have not heard of that.—One of my officers told me that the last time he was there they had a dredger at work.

415. (*Admiral Sir George Nares.*) May we take it that wherever the entrance is you would still put to sea in a cyclone?—I think so. If I were to form and to act upon my own judgment, nothing would induce me to remain in. First of all, I should have to bear in mind the possibility of the walls breaking down and giving way, and the sea making a breach through the walls. There is nothing that would hold a ship in there. I do not know how we could hold on to anything. I think, whatever other men may do, you may take it for granted that I would not run the risk of remaining there if I could get out to sea. I would rather trust myself to the open water.

416. Then, from a sailor's point of view, it would be merely an advantage commercially for the landing and discharge of goods, and not for a harbour of refuge in any way?—I think so; so far as these large steamers are concerned, certainly. I do not know what a sailing ship might feel inclined to do if it were in there. Probably she would not be able to get out.

417. (*Chairman.*) Can you remember whether, when you were there, there were any sailing ships in the harbour?—I do not think there were. The sailing ships were lying just outside the harbour, just about *here* (*pointing to the plan*).

418. (*Admiral Sir George Nares.*) Is the cargo landed inside the harbour or outside the harbour?—That I could not say. I believe that at that time they brought their boats inside. They took the cargo out of the vessel, put it into boats alongside, and then brought the boats into the harbour, to the landing jetty.

419. (*Sir John Coode.*) Were they actually discharging the cargo outside the harbour?—Yes; that is where we always used to take it.

420. "Used" to do it, you say; do they do so still?—The sailing ships were doing it when I was there.

421. Have you any idea how many sailing ships there were in number?—I think there were three or four lying there.

422. Is that a common practice?—I believe all the sailing ships discharge outside still. I do not think they go into the harbour, but I am not able to speak positively as to that. I do not think a sailing ship comes in; it discharges outside. This is practically of use for steamers coming there and wanting quick despatch. The vessels go in night and day. As far as I understand, there is no difficulty in going in or coming out. We did not go in at night because I had not got hold of a pilot; but vessels do come in at night. In fact, they enter and leave during the night.

423. I suppose there is a light on the jetty at night, is there not?—I think there is. They ought to have lights *here*, but they had been washed away. That was really the explanation.

424. But if they were to have leading lights on the jetty a man might go in at night, might he not?—He might go in at night if they had a light on either arm.

425. Then on the occasion to which you referred just now you could see no lights at all?—There was no light at all. I had nothing but the big Madras light to go by for my bearings.

426. Then I understand that you think a width of 450 feet would be enough, but you would not like to see it narrower?—I do not think it should be narrower; but I think 450 feet would be ample for large vessels coming in. It is only a matter of a minute or two before they are past the entrance. It all depends upon how you point your ship. In about two minutes it is all over; you are in, and out too.

427. (*Admiral Sir George Nares.*) Do you know anything about the current flag that is hoisted, and when the surf boats may charge extra fees?—No, I do not. I do not carry these things in my mind. We always

Capt. G. N. Hector. 27 April 1887.

have the rules sent off to us; they are published and sent off.

328. It might be called the current flag and you be attributable to a heavier wind outside for giving them better fees?—Yes, it might be so.

329. But, as far as you know, you have not experienced a side current in entering the harbour or leaving it?

Capt. T. Alderton.

Captain THOMAS ALDERTON examined.

330. (*Chairman.*) What is the name of your ship, please?—The name of my last ship is the "Nepaul."

331. Have you a ship now?—No, I have just left my ship; I might say I have not been out of a ship for many years. I have only been on shore a few days.

332. Have you been within the last, say 10 years, in the habit of using Madras Harbour?—Yes, a great deal.

333. You had, therefore, an opportunity of seeing it in the course of construction and also when it was complete?—Yes.

334. And you have experienced weather of all sorts and descriptions at Madras, I suppose?—Yes, I have.

335. Have you ever found any difficulty in taking up your berth in the harbour?—No; not any very great difficulty.

336. Have you ever found any current across the mouth of the harbour?—Yes, very strong indeed.

337. Sufficient to affect you in turning in?—I think, to any sailor, it offers no very great difficulty. For instance, I pick a pilot up outside (or see by the way the ships are swinging how the current is setting). When pilot comes, I say "How do you find current at entrance?" He will reply "Strong," or "Weak," "North," or "South," as the case may be. I may have found it strong outside in open sea.

338. It varies very much according, not only to the strength of the wind, but the duration of the monsoon, does it not?—Yes, it does.

339. With regard to the sea at and outside the entrance, you have two seas to contend with, I think; the regular easterly swell that eventually breaks on the beach and the swell or sea due to the wind?—Yes, you do; that is quite right.

340. Do those, combined or apart, add much to the difficulty of "taking" the harbour?—I do not think so, in any ordinarily powerful ship.

341. Have you ever been there under any circumstances of weather when you have decided not to take the harbour?—Only on one or two occasions. The bad weather or storm signal was up when I anchored outside on one occasion. The next day the master attendant said by note and pilot I might come in if I liked at my own risk, and thinking bad weather had passed I went in. On another occasion also it was very bad weather, and he would not give me permission to go out except at my risk; that was at night.

342. (*Sir John Coode.*) To go out?—To go out at night, and I said I would take the risk (if it was a risk) if he would lend me a pilot boat, and I went out at night.

343. (*Chairman.*) When you say the storm signal was up, do you mean that that was the warning of a cyclone?—Yes, when I anchored outside. There was bad weather about.

344. (*Sir John Coode.*) That is on the first occasion of which you speak, is it not?—That is the first occasion that I speak of. I anchored outside and I went in next day. The next day he sent me off the assistance of a pilot, and to say it was rather risky; would I come in. I had a good many passengers aboard and a great deal of cargo for Madras. In my opinion I did not think I was running very much risk; there was no vessel inside, and I went in and stopped there by myself till I finished my business, and then I came out again.

345. (*Chairman.*) Had you no reason to believe, from your own barometer, that a storm was threatening?—It had been blowing a good deal, but I thought it was over. I thought it had passed us. Had it been the commencement of the storm coming on, and I had thought I was going to be in there in a kind of trap, I most certainly should not have gone in, I should have remained outside. But I thought, though there was bad weather about, that the cyclone was past, and I went in and did what I had to do. Of course I should prefer the open sea to remaining inside the Madras breakwater as it was then. It was in rather a dilapidated condition at that time, and there was not much protection for you.

346. That is since the destruction of the breakwater?—Yes.

347. When the breakwater was perfect, did it make much difference to you—we will say with a south-west monsoon—which side of the harbour you anchored as to the conditions of sea for loading and unloading?—I think I should prefer off the pier down the south side during the south-west monsoon, and during the other, the north-east corner. The weather corner is best with the north-east monsoon.

348. It would be the best, naturally; but what I mean is this, would the state of the sea inside make much difference to you with regard to loading and unloading if all the berths on the weather side were filled up and you had to take your berth on the lee side?—I think it makes a great deal of difference. If you get in what you may call the snug corner you can work your boats on both sides. If you have the outside berth you can only work the boats on one side of the ship. I have seen them sometimes capsized, and all the cargo has gone into the water.

349. Still, the harbour gives a very considerable amount of protection compared with what you get outside, does it not?—Yes, I think so, most certainly, and particularly now. I have been there lately, since they have been repairing it. When we had the boats on, steel, and when there was a good deal of mixed swell rolling in, was when it was in a very dilapidated condition—when it was only a breakwater in name—a few blocks cropping up just above the water in one place and another and the sea breaking on them.

350. Have you formed any opinion as to the position of the entrance?—Yes.

351. Will you look at that plan—*that* being the present entrance, and *this* being the proposed entrance or suggested entrance—have you thought over the question at all?—Yes, I have.

352. Will you give us the benefit of your opinion, please?—From what I know about it I prefer the old entrance as it is.

353. What is the length of the "Nepaul"?—The "Nepaul" is 375 feet long.

354. Will you imagine yourself taking the "Nepaul" in by a north-east entrance covered by a protecting arm, under, we will say, ordinary circumstances, with a sea breaking in five fathoms, a north-east monsoon of medium strength behind you, and with a roll upon your broadside?—I may say, to begin with, I understood they were only going to cut a gap in the breakwater, and I have not studied this question at all with reference to the projecting arm.

355. [illegible] will come to the unprotected one afterwards?—Do they purpose to lay down, say buoys or simply to run in?

356. I am simply talking about manœuvring your ship.—Well, I would rather use *this* entrance. I think there would be a difficulty in a following sea, because I have thought it out in this way. With a strong following wind and a beam sea, my ship would not be under good command unless I kept the engines moving; and then in going into a small place like that I might have too much way on, and, it may be, a dangerous amount of way, unless with bollards or buoys to check you.

357. In fact, you would not think it a good entrance to take except under very favourable circumstances?—Yes. It might perhaps answer in three-fourths the time, but in the north-east monsoon, with heavy squalls coming down, I should not like to do it.

358. If you take away the protecting or projecting arm, would that affect your opinion?—I think it would be more favourable with the protecting arm. I think to take away the protecting arm would increase the difficulty.

359. The present entrance being 550 feet in width, would you see any objection, for the sake of getting smoother water inside, to its being narrowed to 450 feet?—No, but not more than that. I would not have it narrowed more than that.

360. You would not reduce the width more than that?—No, I would not.

361. (*Sir John Coode.*) You would not reduce it to less than 450 feet?—No, I would not.

362. But you think that would be enough?—I think it is narrowing it quite sufficiently. I think it is going as near as you can. If too narrow I think it would affect the ship's steering very much. If you cannot get rid of the displaced water your ship will take a sheer up either one way or the other; but with the breakwater at its present width I find no difficulty in that way; the ship steers. I think with reference to this and the current running across, that men who are accustomed to handling ships, and pilots of ordinary skill, would learn to overcome that difficulty about the current. You steer either for one breakwater or the other, and you know when to take the way off.

363. (*Admiral Sir George Nares.*) Do you know of any vessel that in entering or leaving has ever touched the breakwater since it has been in its present position?—I went in there the other day when a ship was washed over it altogether.

364. I ask you that in connexion with the breadth of the entrance?—No, I do not remember any. I only remember the pilot telling me that they very nearly struck *this* southern pier—that is all. I do not remember that any vessel has ever struck it.

365. What do the sailing vessels that trade to the port do; do they enter the harbour?—Never. I have never seen a sailing vessel inside.

366. (*Chairman.*) Do you mean throughout your experience there?—Yes. I have never seen a sailing vessel inside Madras Harbour.

367. (*Sir John Coode.*) How many have you seen outside at one and the same time?—I should think eight to 12 or 14.

368. That is not an uncommon occurrence, is it?—Oh, no. It seems to be a matter of established fact that no sailing vessel ever attempts to come in.

369. (*Admiral Sir George Nares.*) Is that because there is no room in the harbour, or that your steamers take up all the room?—No; it is partly on account of the harbour dues, and they could not get in and out very well unless they were towed in and out.

370. And there is no tug there?—There is no tug there.

371. (*Sir John Coode.*) Would those vessels have lain at the same distance off shore before the harbour was made as afterwards?—I think they get a little shelter sometimes from the harbour works.

372. What I want to know is this—has the existence of the harbour works caused them to lay further off shore than they did previously?—Not at all.

373. They are lying now in about the same position that they did before the works were commenced?—Yes, they are all clustered about *there*. Of course, if a ship is anchored right in the entrance to the pier they make him shift, but I think they are in the ordinary position.

374. I am speaking of the distance from shore?—Yes, quite so. They are in the ordinary position. I do not think the harbour works have made any difference at all.

375. (*Admiral Sir George Nares.*) I suppose they land the cargo from the sailing ships inside the harbour?—Yes, some of it. A good deal goes so to the pier. They swim the horses ashore, for instance, from the Australian horse sailing ships. A good deal of the cargo goes in the Masula boats still—fodder, fittings, and rough cargo.

376. (*Sir John Coode.*) On to the beach outside the harbour?—Yes.

377. North and south?—Yes. I have seen a good many boats land cargo, but mostly to the south. I do not think I have seen any cargo being landed north excepting timber.

378. (*Admiral Sir George Nares.*) That would be to escape the harbour dues, would it not?—Very largely to escape the harbour dues.

379. When the surf is breaking outside the harbour, in about what water would it be breaking in an ordinary north-east monsoon on the Madras beach?—Soon after north-east monsoon on the Madras beach begins to curl. I *this* five-fathoms line is passed it begins to curl. I suppose in about four fathoms or 3½ to four fathoms.

380. And even now, in the present damaged state of the harbour, can you give us any idea of the surf inside?—Well, you will have it laid down possibly some distance inside of where the buoys are. I do not see it laid down *here* off the pier. Say that those buoys are in 4½ to five fathoms; then about 100 to 120 yards inside of that the surf begins to break, say two-thirds of distance from beach to west of pier head.

381. And is it so much surf that the boats cannot land their cargo?—Of course, what I am speaking of just now is, in downright bad weather, when the sea can come right over the top of breakwater. If the wind is off-shore and there is no real bad weather about, the surf on *this* line is a mere nothing, it is no more than you would see on Brighton beach.

382. We are told that the rain of the breakwater is, even now, up to low-water line?—Yes.

383. Therefore there would be considerable shelter inside it in its present state?—Yes, there is. When I was last there that wall on the north side afforded considerable shelter, although there was only one tier of blocks.

384. (*Sir John Coode.*) That is to say, one tier of blocks above water, you mean?—One tier of blocks above water. I think they were laying some additional blocks, if I remember rightly, above water.

385. (*Admiral Sir George Nares.*) Then, if the north and south arms are raised six feet higher, there will be considerably more shelter?—Yes, very much more shelter. When we get anything like the Colombo breakwater you have pretty nearly all the protection you want for a ship.

386. (*Sir John Coode.*) This will be quite as high as that when finished, will it not?—Yes.

387. (*Chairman.*) Under ordinary circumstances, average circumstances I mean. I do not mean the most favourable circumstances or the worst,—but under ordinary circumstances, could you ever land in your own gig on the beach inside the harbour without getting a wet jacket?—No; all the European-built boats go to the pier. I have gone ashore in a Masula boat there. I should think when *that* tier of blocks is put round these, you might land in an ordinary ship's boat. I do not see any difficulty.

388. Does your answer hold good in the south-west monsoon as well as for the north-east?—More particularly the south-west monsoon, because it is off-shore, if I understand your question rightly.

389. I am speaking about the surf on the beach?—The surf on the beach in the south-west monsoon. My answer applies in this way; boats of European build are now used to go backwards and forwards from the ships to the pier. I have not yet seen them attempt to land on the beach.

390. In either monsoon?—In either monsoon; though it appeared to me to be quite feasible for them to do so.

391. (*Admiral Sir George Nares.*) Is the present disturbed state of the water inside the harbour brought about by the water coming over the breakwater or by coming through the entrance?—I think more largely by coming over the breakwater.

392. (*Sir John Coode.*) In ordinary weather?—Well, if it is fine weather there is no disturbed water.

393. (*Admiral Sir George Nares.*) In the monsoon?—In the north-east monsoon the water comes tumbling over *there*, or did do so, in the dilapidated state in which it was, and of course made it like what sailors call "a boiling pot." No doubt there is a certain amount of draft in and out through the entrance; it breaks over the side, fills the place up, and then it rushes out, I noticed.

394. (*Chairman.*) Yesterday we had some evidence to the effect that during the south-west monsoon two large ships that were named were inside the harbour pitching and rolling most unpleasantly. At that time the harbour was at its best. Have you ever seen anything of that sort?—No.

Capt. T. Alderton. 27 April 1887.

Capt. *T. Alderton.*

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495. You never saw the inside of Madras harbour when the harbour was complete, I understand?—Not so frequently. What has been remarked by me and by others is this: for instance, suppose that the wind has died away and that there is a good deal of sea rolling in, then it has been so irregular in the harbour that we could have discharged our cargo more readily outside; that is because it has made this sort of "bobbing pot," while outside there was the old regular and even roll. I should think that the arm was of advantage, taking it altogether. I do not know whether I ought to make one remark. I do not know what they are going to do with reference to any buoys, but as I was saying just now, with reference to this entrance in coming in there, you are now obliged to judge your distance in letting go your anchor. You have to come in with a certain amount of way on. Say that you are going to take up a position there, you come in here, you let go your starboard anchor, and you keep a certain amount of way on, run out 75 fathoms of cable, then drop your port anchor. I am not speaking feelingly, but it has led to the parting of a good many cables, the loss of hawse-pipes, and a good many anchors. Of course, when this shall be on and many ships anywhere, your cable parts and runs very good chance of running some other ship down, and it leads to constant altercation between captains and pilots and the owners of the ships, so that it struck me that it would be an improvement if there were buoys, instead of having to judge your distance. You are sometimes obliged to roughout, or the anchor comes home, or some such thing happens, and you have not got your berth quite safe. When I was there once, in very bad weather, they brought the rocket apparatus down, as they thought we were going ashore. Our cable parted.

496. (*Admiral Sir George Nares.*) Inside the harbour?—Yes, inside the harbour. I have had simply a couple of feet to go upon under the ship's lights under such circumstances. I cannot veer any more cable. Then a ship we will say, for instance, of about 4,000 tons, carries an anchor possibly of three tons. Well, it is out of proportion to the size of the ship unless you ride with a long scope of chain. Lying with a short scope like that and with a joggle of a sea, you cannot afford to veer cable, therefore you want some heavier moorings laid down into real bottom, not in sand.

497. (*Sir John Coode.*) Have they not some moorings at Madras now which have not been laid down?—I spoke about it when I was there and they told me: "We have some moorings and they are lying on the beach."

498. I understood that moorings were sent to Madras a considerable time ago, or two or three years ago, and I was surprised yesterday to hear that none of them were laid down?—None of them were laid down.

499. Do you know why?—No. Then we make fast to a buoy at the stern of the ship. We have had several fights with the master attendants and pilots about that; they will not let us run out our wire hawsers—it is to run out to it you may as well take the buoy ashore. The wire that we shall lose the buoy and all moorings out of the ground; in answer to that we say, "Why do you not put down stronger moorings?" They send a note to tell me that in the event of any ship breaking adrift, I am to take precautions; but if another ship's line is carried away and she swings right round on me, or within five feet of me, what precaution can I take?

500. (*Chairman.*) When you parted your cable was it from the sea, or the wind, or both?—From the short scope with the jump of the sea. I recovered it the next morning. I ran a wire out and put a shackle on. That was in exceptional weather. As a master of fact I was warned the night before to go out, and I would have gone out, that is when they said on shore that there was bad weather coming up the coast, but the notice was sent off very late and the pilot came off and said: "It will be down upon us before we can get the ship unmoored, so I will have nothing to do with it." The motion only came off about a quarter to six, saying the cyclone or bad weather was coming up the coast. I said: "Well, if we are going to make a bash of it on the top of the breakwater, we will remain where we are," so we remained where we were. I had the sheet anchor and stream ready and the starboard cable carried away afterwards.

501. (*Sir John Coode.*) Where were you moored at that time?—I was moored just at the north of the pier.

502. Of the jetty?—Of the jetty; the Madras pier or the Madras jetty.

503. (*Chairman.*) Do you happen to know how far from Madras that particular cyclone passed?—I think it was down between Madras and Pondicherry, and when I went in the other day also there was a good deal of sea on. That was just after a cyclone. A cyclone passed over and went into the Arabian Sea, and it was then that this sailing vessel, of which I have spoken, was washed over the breakwater. She was bottom up when I came in. Mine was the first vessel inside afterwards. I came up the next morning in moderate weather. I had turned round and gone to sea the day before to avoid the strength of the cyclone, and did so.

504. (*Sir John Coode.*) Had she been moored outside?—Yes. His cables parted; the breakwater did not offer him very much shelter to-day, and he washed clean over it. The ship was not fitted, so far as I know, [illegible]

505. (*Chairman.*) What sized ship was it?—They told me it was one of the old East India Company's ships that had been bought by natives.

506. (*Sir John Coode.*) Was she's mere hull; had she any spars?—No, the masts were standing in the sand; she was bottom up.

507. How could she get over the breakwater, she must have got over on her keel and turned after she got over, must she not?—There was a good deal of sea on. She simply "lifted" over. You could see the copper bottom.

508. Then she capsized after she was over on the other side?—Yes.

509. (*Admiral Sir George Nares.*) In what year did these events occur of which you are telling us? I mean the experience that you have been speaking about. We have not had it stated whether it was before the harbour was completed or since. Is it since 1881?—Yes, since 1881, before they commenced the late repairs.

510. Were you inside the harbour when it was practically complete before the damaged was done?—Yes, I was.

511. And then was there all this confused sea; was it much the same as before?—My experience of it in the complete state was not so very great. I have noticed all this confused sea more particularly since the damage has been done by the cyclone, and since the harbour has been in its dilapidated state. I did not make any objection to using the place at all, and I think there was a good deal of protection from it when it was in its complete state. I mean some commanders thought it was so small that they did not care about going in at all. I got out at night by sending out a couple of coach lamps; a man at each buoy. I wanted to get up to Calcutta to save a tide.

512. And the breadth of the entrance was amply sufficient then?—Yes, I have never found any difficulty there about the ship's steering. That is the great point in going through these narrow places. The moment water does not get to the rudder. I mean you draw the water in after you in a narrow entrance, and the ship will not steer. You must have a sufficient escape for the water so that the ship will steer.

513. (*Chairman.*) You think the entrance is not long enough?—It does not close in again on the rudder. You draw the water after you.

514. (*Sir John Coode.*) It is totally different from passing through the canal?—It is similar to passing through the canal.

515. But not anything like to the same extent?—No, I say I find no difficulty there. I say that to any practical seaman or pilot the present width of the entrance of Madras harbour will offer no difficulty; but in the canal, if you have a ship with any great beam, as Sir George Nares knows, and you go over a certain speed, your steering begins to get "wild," and your ship cannot stand it, you must ease speed again.

516. That is why I said just now it is not like passing through the canal?—I misunderstood you.

517. (*Admiral Sir George Nares.*) With regard to taking the entrance going out of the harbour, would you prefer it where it is now or at the north-east corner?—I prefer it where it is now.

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518. (*Sir John Coode.*) Either with or without the protecting arm?—Either with or without it. I was talking with a pilot on the bridge the other day, as we were getting under weigh to come out. The vessels are lying more parallel to *this* northern arm; say that I am *there*, off the pier; *there* you see you have the entrance pretty clearly before you, and you can manœuvre your ship either one way or the other with a line from the buoys, but you have to make a sharp turn, and to go across other ships' cables to get out of that northern arm. I said there will be a chance of hooking their cable with our screw, and I shall find myself with a ship 400 feet long across the bows of two or three other ships. If you have a powerful tug forward and aft, you can always make your way. If you had moorings and so on it could be done. We find no difficulty in Colombo. With the moorings there laid down we go in. Still, I think, the natural difficulties of Madras, in that way, with the sea tumbling in, are more than they are at Colombo.

519. (*Admiral Sir George Nares.*) In going to sea you would sooner face the rollers, bows on, going out of the entrance, than go out at a north-east entrance and face them abeam?—I think I would. Another reason has been that at another time, if I make a shoot *here*, I can anchor in nine fathoms if anything goes wrong with the engines, and it has occurred to me once or twice that something has gone wrong down below; and then, if I am going out *this* side (*pointing to the plan*), I have not so very much room. If I veer cable I am close to breakers.

520. What vessels are those you were speaking about that are anchored inside there now? What vessels use the harbour besides the steamers?—No vessels use it besides the steamers.

521. What do the small coast craft do?—They almost invariably anchor to the north.

522. Then they get the protection behind the breakwaters?—Yes.

523. (*Sir John Coode.*) Do they land their cargoes on the beach to the north?—The natives are mostly anchored to the north of the breakwater.

524. Have they not constructed a stone revetment along the beach there which would interfere with the landing?—I suppose it would now. In the north-east monsoon they come round *here* to seek shelter. Small steamers come up for orders and anchor under the lee of the breakwater. They have it very nice and smooth there, but the native craft almost invariably prefer *this* part.

525. On the north of the north breakwater you mean?—Yes. All the country craft prefer the north of the breakwater, and all the European ships moor to the south-east and south.

526. In the case of a north-east entrance without the protecting arm you will bear in mind that your vessel would not have to come so much broadside on to the swell, coming in, as if the protecting arm were there?—I think the protecting arm would be a very great advantage to the scheme, undoubtedly.

527. As regards shelter within the harbour, of course it would?—Oh, yes.

528. My point is this: assuming, then, for the moment, that there was no protecting arm, you would not have to bring your vessel so much broadside on to the swell to get into the harbour as you would if the protecting arm were in existence?—Quite so.

529. (*Admiral Sir George Nares.*) But without the protecting arm there would be as much sea in the harbour with a north-east monsoon as there would be with the entrance as designed?—Yes, I am inclined to think so.

530. (*Sir John Coode.*) That is a point to be apprehended, you think that it would be so?—Yes, I am inclined to think so, and I have talked with a pilot quite lately about it. I did not know exactly what the scheme was, but he said: "They talk about making an entrance through there to the north-east." We said, "Looking at the heavy sea breaking on that north-east "corner now, how it will come tumbling in with an "entrance." There is a much more regular swell coming in through the present entrance. That is what the pilot and I thought in talking it over.

531. (*Chairman.*) Were you at Madras last year?—Yes, I was.

532. There is a report dated the 20th September 1886, speaking of the effects of a gale they had experienced there a short time before in August. It says: "The "wind at no time blew greater than 22 miles an "hour and did not attain the proportion of a gale, the "difficulty experienced by vessels in getting out was "owing to the opening in the east." It also says: "At 12 the sea had roughened up so much that the "three steamers in the harbour made several attempts "to go to sea but were blown round again" (that is with the wind from the north-east) "and it was not "until 2 p.m. when the third steamer steamed out. "The wind was north-east still and the sea fairly "heavy, washing over the north pier from end to end, "except at the wave breakers, which retarded the "waves wonderfully." Can you carry that in your head and give me an opinion as to whether you think that a north-east entrance would have been better for those ships to go out at than an easterly entrance?—Yes. It is possible that if a vessel were there alone, or two vessels with that protecting arm, and they were heading exactly in *that* direction, and their hawsers were not strong enough to hold by the stern at *this* entrance, that *that* would be a better one; but taking it altogether I have never found any difficulty with the present entrance. I have gone out when it has been blowing very, very strong, and I could get whatever cant I wanted by my hawser and by a slight movement of the screw to use *this* other entrance.

533. The question is, whether under such circumstances, with the wind strong from the north-east, and with a heavy sea outside, you think it would have been easier to get out at a north-east entrance than at the east entrance?—Well, I think, looking at it in that light, that it might possibly be so; but that depends upon the number of ships again. If you have got the space all to yourself it is easy enough. Ordinarily speaking, if we were lying there in tiers, I should prefer the old entrance, because if I am the third ship down, then, in order to get up to *that* north-east entrance I must cross the bows of the other two; I must cross their cables. In the other way we are all facing to the eastward, and if I am *that* ship, or the centre ship, or the ship to leeward, I have got the entrance before me and I can heave up my anchor, haul on the stern ropes, and manœuvre the ship and get out more readily. It was in that way that I went out at night, when it was blowing very strong. The pilot took no responsibility. I put the pilot in his boat *here* (*pointing to the plan*) owing to the sea outside. He told me afterwards, "It came down tremendously just as you went out." The lights went out at the buoys, and I was obliged to go dead slow for two hours afterwards. The rain came down blinding thick. I only had to shoot those few yards when pointed.

534. Then you do not think that the instance quoted *here* is a sufficient argument about changing the position of the entrance?—No, I do not think so, because that night that I went out it was very bad weather, but I found no great difficulty.

535. You do not know anything about the state of the restoration works, do you?—Well, I was there last September or October.

536. *This* speaks of September?—They put a good many blocks along *here* (*pointing to the plan*), and a good many blocks along *there*, and I saw the trucks down there, and that they were shooting rubble outside on sea face; and I think they were shooting something inside, but I saw them shooting principally rubble on *that* side, and they had a good many blocks in position. Then they told me: "We are going to get the cranes in now, we are going to get the titans in." It was very equally weather then in September.

537. Do you remember the circumstance of a barque on the 23rd May running on the north pier and being destroyed—in fact wrecked?—No, I do not remember that.

538. (*Sir John Coode.*) Were you there about that time?—I was there in April.

539. This occurred in May?—I do not remember the circumstance. I only remember that circumstance I mentioned of the vessel being washed over.

540. Had you noticed anything in regard to the wave breaker that was spoken of just now?—It appeared to me that every block put along there seemed to make a great improvement.

541. (*Admiral Sir George Nares.*) You have not noticed any difference as regards the sea coming over the part of the breakwater where the blocks are placed in front of it, and any other part, have you?—I think the difference is simply when the swell comes in where

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the breakwater is dilapidated. In the other place where the blocks are placed another tier higher it only comes over and runs down in buckets-full, comparatively speaking. It does not disturb the sea.

542. Then the fronting blocks have considerably improved the breakwater?—Very much so, I think.

543. What is the ordinary direction of the wind at the end of May—say on the 25rd May?—At the end of May it ought to be from the south-west.

544. Then if the wind was strong from the north-east at that time it must have been a cyclone?—Yes, in May it would be an unusual thing to have a north-east wind there.

545. The case we have been speaking about was an exceptional case, was it not?—Quite an exceptional thing.

546. On ordinary occasions you would prefer to have left the harbour before the cyclone had come on?—Yes.

547. And that is the usual practice of all ships, is it not?—Yes, always to get and to keep outside.

548. And wherever the entrance is, if you are caught inside there will be a difficulty in getting out, will there not?—Yes, great difficulty in getting out. If it is once upon you it will be dangerous to move your ship, but they have such good telegraphic communication now that they ought to give you notice, and we usually keep steam ready.

549. (*Chairman.*) If your ship were to be wrecked inside the Madras harbour in the cyclone, what would be the effect upon the insurance?—Oh, it is a risk of the sea—a "peril of the sea."

550. In spite of the warning signals?—I think the captain would be very severely handled if he did not take notice of the warning signals.

551. I am not speaking of the captain, I am thinking of the company now. What would be the effect upon the insurance, do you know?—It is rather a knotty point. I think it is every man's duty to preserve his ship and his cargo without reference to documents, but if the warning signals were up and a man refused to obey them, having time to do so ——

552. Would the insurance be forfeited or not if the ship were lost?—No, I think not. It depends upon the way the policy is issued. An underwriter may take a risk from the time the goods are shipped at Manchester until the time they are landed in Calcutta. The policy may include every kind of risk, and for that he is paid so much. Then, on the other hand, a policy may only begin possibly when the goods are absolutely embarked on board the ship without covering any fire or intermediate risks, and for only certain ports, and it may be so worded as to accept perils by fire and of various kinds by land and sea, from pirates and many other things. There is also a clause against default, which may include the "ignorance of mariners." Some risks are covered in that way.

Capt. J. Henderson.

Captain JAMES HENDERSON examined.

553. (*Chairman.*) You command the British India steamship "Goorkha," do you not?—Yes.

554. And may I presume that you have commanded other ships of the same kind?—Yes, I have been in the habit of going to the coast of India.

555. During the past 10 years?—Yes.

556. And during that time have you frequented the Madras harbour?—Yes.

557. During the construction of the works?—Yes, from the commencement of the works.

558. When the harbour was at its best, when it was complete?—No. The cyclone came on before I went out there the last time. I never saw it completed. I saw it nearly completed.

559. And since it was destroyed?—And since.

560. Have you ever experienced any difficulty in "taking" the harbour with the entrance in its present position?—No.

561. Or in leaving the harbour with the entrance in its present position?—No.

562. Have you ever found the current crossing the mouth of the harbour in such strength as to render it difficult to "take" the harbour?—No. I have never remarked it.

563. You say that you were not acquainted with the harbour when it was actually complete, but were you acquainted with it when it was nearly complete?—Yes. I was frequently calling at Madras from 1878 to 1882.

564. Can you remember whether you were in the harbour at all between March 1881 and November 1881, the date of the cyclone that did so much damage to the works there?—Yes, I daresay I was there in 1881.

565. During that time the works progressed very rapidly towards completion, and made at the same time a very sensible difference in the width of the opening, did they not?—Yes. I was there in the end of 1882. During the first part of 1882 I was in Egypt.

566. I think you may say that at the present time the entrance is nearly what it was when the works were complete?—Yes, just the same.

567. The same danger (if there is any danger) to ships entering or leaving still exists?—Yes, it is just the same now.

568. And I understand you to say you have not experienced any difficulty in entering or leaving?—No, I have not.

569. And that in any weather in which you would take the ship in at all you would have no hesitation in doing so?—I would have perfect confidence in entering as it is.

570. With regard to the water inside the harbour, as you say, you cannot answer as to what it was at its best?—No, I never saw it completed I think.

571. But, I think, you may say practically, that during the north-east monsoon, the south side of the harbour was more or less rough, and *else were*?—There is a joggle of the sea inside the harbour.

572. Have you ever been placed in any danger by the sea inside the harbour?—Yes, the last time I was in it. Last year, in the "Goorkha," I felt very uncomfortable one night when I was there. There were blowing strong squalls from north-east, and it was very threatening weather. It came on at night.

573. Can you give us the date, or about the date, of that?—In November, I think it was, last year.

574. I think we have the report of a cyclone storm in May of 1886?—It was during part of a cyclone when a P. and O. steamer was in the harbour. November, I think it was.

575. Were there any warning signals flying at the time, do you know?—No, not until afterwards.

576. The sea came in without any warning?—It was blowing hard at the time with heavy squalls from the north-east. Of course there I could not pay out chain. I had one of those large buoys that are there under the steamer's stern, and it was most dangerous, and there was no way of getting out. It was too dark. I could not see the entrance.

577. Had it been light could you have got out? When I say "could you," would you like to have taken your ship out?—Yes, I should have preferred to be out rather than inside, certainly.

578. You would have preferred taking her out to remaining inside?—Yes, if I could have seen the entrance.

579. Has it happened to you often that your loading and unloading has been interrupted by the state of the sea inside?—Yes, it has been interrupted. That is, as the harbour is at present. It is pretty well broken down.

580. Did that occur throughout the year, or was it particularly confined to the two months of the change of monsoon?—The change of monsoon.

581. At other times you can calculate upon carrying on your work with fair regularity?—Yes, unless there is some disturbance in the Bay of Bengal, which sends an easterly sea in. Then it interferes with the work, although there is no wind in Madras at the time, perhaps; it is just the sea comes across.

582. Have you ever formed an opinion as to the position of the entrance to the harbour? Do you consider that the harbour could be improved by having the entrance in another position?—It might improve the harbour, but I think it would be very dangerous for ships to go in.

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583. Will you look at this plan? You see *there* that there is a projection of an entrance at the north-east corner, covered with a protecting arm. Should you prefer that entrance in a north-east monsoon, with a beam sea breaking, we will say, half-way along the pier, roughly, to turn your ship into the harbour?—No, I do not think so. With a ship 400 feet long it would be a most dangerous space to come in at with a heavy beam sea. Your stern would be out in the rough water when your bow was protected by *that* breakwater. I do not think that it would be very safe.

584. From a seaman's point of view, then, are we to understand that you prefer the eastern entrance—that is, where it is now?—Yes, I should think so. It would be dangerous for boats coming out *there*. They would come out to a broadside sea if there was a sea from the eastward. If it was blowing from the north-east with a heavy sea *here*, it would be dangerous for a pilot boat to go out.

585. You think it would be much more dangerous than at present?—Much more dangerous. She is head on to the sea *here*, as a rule, or very nearly.

586. When once you had, so to speak, "shot" the entrance, would you be in as good a position for bringing up under those circumstances during the north-east trade as with the entrance where it is now?—No, nothing like so good a position.

587. (*Sir John Coode.*) You knew Madras, I understand, before the works were commenced?—Yes.

588. How many times have you been there since the piers were started?—A great number of times. I was coasting round between Bombay and Calcutta, calling at all the ports, Madras amongst them.

589. Say, within the last six or seven years, what would be the average number of times per annum that you have visited Madras. Give us the average, roughly?—I suppose about a dozen times.

590. Each year?—Yes, each year. Coming and going. I was coasting between Bombay and Calcutta, calling at Madras both ways.

591. The Admiral asked you just now, with regard to the discharge of cargo; have any interruptions occurred from time to time when you have been in the harbour, in consequence of this "joggling" sea?—Yes; and there have been losses of cargo as well. You see, the steamer does not trouble about it; it is just the little boats alongside. There is rather a nasty pointed joggle of a sea now, with the breakwater as it is at present, broken down. It is almost worse than a heavy sea outside—at least, worse than a sea outside.

592. Then, on those occasions of your visiting Madras harbour, after the knuckle had been turned—you know what I mean by the "knuckle," do you not?—Yes.

593. Did you observe any great difference in the quietude of the water inside as the works progressed towards the entrance?—Yes; these corners, of course, were quiet (*pointing to the plan*). It was the centre part that was not.

594. But as the arms advanced towards the opening, did the benefit appear to be increasing?—Yes.

595. Was there a visible difference?—Yes.

596. With regard to the width of the opening. The width, as it was, was 550 feet. Now it has been suggested that that entrance should be made 450 feet. Do you think that that would be wide enough?—Yes, I think so.

597. Do you think you could venture with safety to make it less?—Yes, I think so.

598. Would you say 400 feet?—A steamer steering well goes in perfectly straight. She does not take up much more than her own breadth.

599. Because when the sea was heavy it would be either a directly following sea or a directly head sea?—Yes.

600. Therefore there would be no necessity for a wide entrance?—No, I do not think so.

601. Then as regards sailing ships, where do they anchor?—They anchor outside.

602. Altogether outside?—Yes, Altogether outside.

603. How far off?—They anchor just off here, either to the north or south.

604. About two or three cables' length seaward?—Yes; about half a mile, I should think, off the breakwater—half a mile to a mile.

605. What proportion of the trade of Madras is carried on in sailing vessels?—Very little now.

606. What number of vessels would you say you have seen there on the occasions of your visits, as a rule? Of course, one is aware that the number must vary very much?—One or two is the most you see there; but before the harbour was complete at all, there used to be a large number—a least, a fair number—of vessels.

607. And with reference to the size of those vessels, what would be the largest size of the sailing ships?—Vessels of about 1,000 tons I should think. They are vessels that are mostly employed in the Coolie trade to the Mauritius, and vessels of that style.

608. Is there any appreciable portion of traffic from Europe carried on now in sailing vessels to Madras?—No, very little, I should say.

609. So little as not to be worth regarding?—Yes.

610. And I gather from what you said just now that it is decreasing and almost disappearing?—Yes.

611. With regard to the difficulty of landing, where do you land when you go ashore from your ship?—I land on the jetty pier.

612. Can you land on the beach?—Yes, you can.

613. With an ordinary boat?—No. There is a regular surf inside, but, as a rule, no ship's boat could land there with safety. They must have the Masula boat even inside the harbour, as it is at present, broken down.

614. Was that the case when the two arms were nearly completed?—Certainly it was smoother then. You see I was not there when it was entirely completed. You see I was not there when it was entirely completed. You see I was not there when it was most advanced stage?—

615. When you saw it, at its most advanced stage?—The pier is in a line with the entrance. Any little sea there is will go right into the pier, and the surf will disappear at each corner.

616. (*Admiral Sir George Nares.*) We are told that the damage to the breakwater is only above low-water mark, that at dead low water there is in fact a continuous easterly pier now; is the confused sea inside the harbour occasioned by the sea coming into the harbour over the top of the breakwater as well as coming in at the entrance?—There are several gaps below, under water.

617. Below low water?—Yes; but there are only parts of the pier above water even at any state of the tide. There are gaps between *these* boulders. There is a boat's passage through *there*. Masula boats pull out there.

618. At low water?—At any state of the water boats pull out there.

619. Then the disturbed state of the sea inside the harbour now is not only in consequence of the sea that is coming through the entrance?—It is a disturbed state right through the facing.

620. It comes over the face?—Yes. It comes over the top of the place knocked down by the cyclone.

621. And frequently breaks over the north and south arms?—Yes, it does.

622. Have you noticed any improvement since there have been blocks placed in front of the seaward side of the north and south arms; does it come over as much now?—I could not well say. You see I have generally anchored right in the middle, right opposite the pier *here (pointing to the plan)*, and that is right opposite to the entrance gap, but as the pier goes on it is certainly smoother in *here*, up in the corners.

623. You have never been inside the harbour during a cyclone, have you?—No, not during a cyclone, but during bad weather.

624. You cannot tell us the effect of the cyclone—the height of the sea?—It is impossible to tell.

625. We have been told that the underneath part of the pier, which is 18 feet above water, has been struck by a sea during a cyclone; have you ever seen or heard of anything of that kind?—No; I do not think since the Madras harbour works commenced there has been what you could call a first class cyclone there at all. I do not think there has been a very heavy cyclone.

626. Talking about the heavy seas that come in, heavy seas might come in with nearly a calm, might they not?—Yes, if there is any disturbance in the Bay of Bengal, it might send a heavy sea on to the Madras coast, some hundreds of miles from where the wind was. That is often the case.

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627. On this occasion, at night time, when you were rather anxious and would sooner have got outside the harbour, that was with a north-easterly wind, was it not?—Yes.

628. To what part of the harbour was this?—I was lying in a berth.

629. (*Sir John Coode.*) Near the centre?—Near the centre.

630. (*Admiral Sir George Nares.*) Then you were not under the shelter of the northerly arm?—No; there was a P. and O. steamer here which was in a better position than I was. I was not under it, but at all, and I was some distance off. There was a nasty sea, I had not much room out, and could not pay any more out owing to this big buoy that was under my stern.

631. In the breadth of the opening we have been told that the rollers, irrespective of the wind waves, come in directly from the eastward; is that so?—Yes.

632. And you say that going out of, or coming into the harbour, you would either face them, or come in with them right astern?—Yes, certainly.

633. Could you make for a narrower opening under those circumstances than you could if you were working with them abeam?—Yes. A vessel that steered well would steer right enough, I think, head to sea.

634. Could you go through a narrower opening on the east side than on the north-east corner?—Yes, certainly. I think so. If you were head on, with the storm to the sea, you would require less room than if rolling about, I think.

635. Then if an opening is made on the north-east corner, it must be a wider opening than it is at the east side?—Yes, I should certainly say so.

636. Supposing this arm were lengthened out 1,000 feet, so that you would have a good space under its lee, that would benefit you, would it not? When you gave your evidence just now you supposed that the arm was not the length of your ship, did not you?—Yes.

637. But supposing it was twice the length of your ship, would it be easier for you to take it then?—The difficulty would be in taking *this* extreme point, where your bow would be under the shelter of *this* end of the pier, but your stern, as you went along, would have the full force of the sea, if there was an easterly sea on.

638. At what distance from the entrance would you have to point your ship straight for it?—Oh, a considerable distance.

639. A quarter of a mile, or half a mile?—As long as she is in a straight line forward, that is all that is necessary; that is as long as she is in a straight line for the entrance. Then she would be rolling tremendously, I think, if out in this position *here*, outside the rollers in bad weather.

640. (*Sir John Coode.*) In the rollers?—Outside the breakers.

641. (*Admiral Sir George Nares.*) At what distance have you seen the actual break of the sea, or in what fathoms of water. Can you give us an idea?—I should say about halfway up the Madras harbour works it would break in very bad weather. On *this* side it would break much sooner than on the other side, because it is sitting up on the south side.

642. Have you ever talked the matter over with other officers about the change of entrance?—Yes, I have talked with the harbour-masters there sometimes. They have spoken to me about it.

643. Mr. Taylor, do you mean?—No, not Mr. Taylor. Mr. Marshall, the assistant harbour-master.

644. (*Sir John Coode.*) Mr. Taylor is the master attendant?—Mr. Taylor is the master attendant; the first assistant master attendant I have talked with.

645. (*Admiral Sir George Nares.*) As there are not many of your captains at home, can you give us a general idea of the opinion entertained amongst the captains of these large steamers. Perhaps you would not like to do so?—Speaking for myself, I would sooner go end on to a sea coming and going. Besides, there is a difficulty in turning a long steamer inside Madras harbour, when you get in. You will be stern on to the sea if it is blowing from the north-east. I do not know how they propose to turn a steamer when they get inside, with an opposite there.

646. Do you turn one by "snubbing" your vessel?—We let go the anchor and turn round.

647. With the chain taut?—Yes; then you are lying head to sea nearly.

648. You do not attempt to turn her at all before you anchor?—No.

649. There is not room, is there, to do that?—No, there is certainly no room, especially if there are any other vessels in there.

650. How many steamers have you seen there of the greatest number altogether?—Five or six I think is the most I have seen there.

651. And there is not much more room for more, I suppose?—No. I have been only once in this corner here since I have been there. I was very glad to get out of it. I was holding on to another vessel's chain astern.

652. (*Sir John Coode.*) You said something about the sanding or silting up on the south side; is that very marked?—It is very marked; if you stand on the end of the pier you can see it.

653. Is it growing outwards?—It is growing outwards very fast.

654. We heard something yesterday about a patch formed on the south side of the knuckle of the northern pier; have you ever seen anything of that in broken water, or any indication of it?—No, I have not.

655. Is the growth so rapid as to excite your attention?—It is remarkable. It seems to be coming away at the north side.

656. Yes, that is admitted. They have had to protect the shore with a revetment of stone?—Yes.

657. (*Admiral Sir George Nares.*) You always go to sea now on the approach of a cyclone, do not you, or you would go to sea if you could?—In the day time. The cyclones sometimes come on at night, and you cannot go out at night at present.

658. (*Sir John Coode.*) You could if you had lights, could not you?—You could if you had leading lights, certainly; you could either go in or come out.

659. Would leading lights on the jetty suffice to take you out at night. Say two powerful leading lights?—Yes, I should think two gas buoys, or something of that kind.

660. (*Admiral Sir George Nares.*) Your wish to go to sea in a cyclone would apply to any harbour in the world, would it not?—No. I should not mind stopping in the harbour of Colombo in a cyclone.

661. Then it depends upon the size of the harbour, does it?—No, it is not the size. It is the exposure. I do not think it will stand a cyclone. I do not think so.

662. Then suppose this harbour is considerably strengthened, as is proposed now, and the walls heightened six feet and the proper moorings laid down, then it would alter the circumstances considerably, would it not, or would you still go to sea?—I would still like to be at sea, I think, in a cyclone.

663. Is that because you would not trust the moorings in a small harbour?—No, I should not like to trust the moorings.

664. Or is it that you would fear the sea coming over the breakwaters; what would be the difference between that and Colombo, for instance?—Colombo is a perfectly safe harbour compared to Madras.

665. In a cyclone?—I should think so. So far south as Colombo there are very few cyclones. There are gales of wind, and even in a gale of wind it sometimes blows very hard there. The sea does not seem to break over there in any way. The water remains perfectly smooth in a south-west monsoon, which is the bad weather there.

666. But if these walls are raised to the same height, then it would depend upon the smallness or comparative size of the harbour, would it not?—Yes. It is difficult of course.

667. I do not want to press you.—I cannot say what it will be like when it is finished, but it is very rough inside at present as it stands.

668. (*Sir John Coode.*) One ought to remark that there is an essential difference between Colombo harbour and Madras in this respect: At Colombo on two sides you have the beach, whereas here you have three walls. At Colombo you have only on one side an artificial work?—Just one arm.

669. If the sea rebounds from the arms it causes the joggle and the unquiet sea that the sailors complain of, whereas at Colombo, whatever disturbance there is, and it is very little, that is lost on the shore, is it not?—Yes, it falls over the pier and disappears at once, but in Madras harbour it is not so.

670. Did you ever see the sea fly as heavy against these walls as in Colombo?—I have seen it as heavy in Colombo.

671. Have you ever seen the sea as heavy in a south-west monsoon at Madras as at Colombo?—In the south-west monsoon at Madras there is no sea at all.

672. I was taking the case of the heaviest sea at Colombo as against the heaviest sea at Madras?—I should say the Madras sea is heavier than the sea at Colombo.

673. Does the sea rise to a great height against *this* work?—Yes. I have been afraid sometimes of the sea touching the top of the pier, which is considerably above the breakwater, I should say. I have seen it so bad that I could not get into a boat from the pier, and had to go out to the breakwater and get into a boat from it.

674. Still, when both piers are raised six feet higher than they ever have been, that will make a difference, will it not? It is intended to raise both these piers six feet higher than they were originally. From what you said just now you are afraid, I gather, that that will hardly be enough; did you intend to convey that?—Yes.

675. Have you been at Colombo during the break of a monsoon, just at the heaviest?—Yes, I have been there during the south-west monsoon.

676. But just at the break, when it burst?—Yes.

677. You seem to be clearly of opinion that at no time since the Madras works have been in progress has there been what you may call, I think, a first class cyclone, that is, a cyclone of the heaviest character?—I believe there has not been a heavy cyclone in Madras since the works were commenced.

678. You think that heavier might be expected at some time?—Yes, I should say so.

679. (*Chairman.*) Do I understand you to say that you think that a heavier sea may be expected?—Yes.

680. It is rather a point whether or not the works have not experienced as heavy a sea as they are likely to be exposed to in the case of a still more direct attack by a cyclone wind, if you understand what I mean?—Yes; but of course the wind itself would not affect the harbour at all. It is not the wind, it is the sea that is the danger there. I think it was the cyclone of 1872 that must have been a very heavy one, when all the vessels nearly at anchor were lost. Outside the anchorage is good; inside it is considerably broken up by the anchors of so many steamers. I do not think it is nearly such good holding ground inside the harbour of Madras as it is outside, owing to its being cut up with anchors.

Capt. J. Henderson. 27 April 1887.

681. (*Sir John Coode.*) Would you like to see moorings put down there?—Yes; I should think moorings would be safer.

682. As far as I gather there is only one mooring down; does that consist with your knowledge?—There are lines that they make fast to large buoys.

683. But nothing more than that for a vessel to make fast to?—No. It is the top of the ring of the buoy; the line is made fast to the stern of the vessel. It is nothing more than a small line. You have to slack on is if it comes on to blow from the north-east. You have to slack off this line so as to allow your vessel to lay head on to the wind.

684. Then these moorings are for merely holding the vessel in that position?—Merely holding the vessel in that particular position in fine weather, and they are a source of danger in weather where you are jumping, as I was one night, with the buoy close under my stern, and could not pay out chain. I fancied I was dragging a little. I did drag a little, and could not pay out more chain, owing to this buoy under my stern.

685. Then these moorings, I understand, are not to be relied upon in the case of a heavy strain?—No, you must slack out.

686. (*Chairman.*) On the occasion you speak of, did the ships in the roadstead go to sea or remain at anchor?—They remained at anchor outside. I would have been comfortable enough outside, anchored, say, in 10 fathoms of water, with plenty of chain. It was not so bad as that. It was simply a nasty joggle of a sea. If my steamer's propeller had struck this buoy astern, it would very likely have disabled me.

Adjourned to Tuesday next at 11.30.

At the Board of Trade, Whitehall.

Tuesday, 3rd May 1887.

MEMBERS PRESENT:

VICE-ADMIRAL NOWELL SALMON, V.C., C.B., IN THE CHAIR.

SIR JOHN COODE, K.C.M.G. | REAR-ADMIRAL SIR GEORGE S. NARES, K.C.B.

MR. F. C. THOMPSON [India Office], *Secretary*.

MR. WILLIAM PARKES, M. Inst. C.E., recalled, further examined.

Mr. W. Parkes, M. Inst. C.E. 3 May 1887.

The witness produced plans and photographs showing the present state of the reconstruction works.

687. (*Chairman.*) You have been good enough to bring these plans and photographs here. Can you give us any data upon which we can judge the time to be taken and cost of altering the entrance?—I have not gone very much into the question of time, and if I did go into it more fully I am afraid that I should not get any more satisfactory results. I am sure I cannot say how long it will take to remove all that submerged work. The estimate of cost I look upon as almost a guess, and when it comes to time I really do not like to make any estimate of it. I should be afraid to make a guess of anything less than two years. The old entrance must be kept open of course. It would keep a portion of the work back until that was done and that entrance made available. I can give you the cost based upon the same prices as are now being paid for new work, and the same prices that Mr. Thorowgood made in his estimate attached to the report of the Madras Committee for removing old work, and I make out that the extra cost (some of the details are put in here) would be, in round numbers, 11¾ lacs. That is rather less than what it came out before, but the main point of difference between the two is that I do not think in the previous estimate (of which I have not any copy) anything was allowed for there being only one pier head instead of two. The additional work at the pier head is rather a serious matter, and I find, according to my estimate for the present sanctioned design, the outer 300 feet of pier costs a lac and a half more than it would do if it were part of the continuous pier, so that that lac and a half, from there being only one pier head, would be saved. The head of the north pier being well under shelter, would be a very simple matter. I do not know that it wants anything.

688. Do those figures cover the closing up of the old entrance as well as the opening of the new?—Yes, they cover the closing up of the old entrance. I have put down upon this plan the estimated cost of the works for closing the entrance and for a length of pier of 300 feet on each side of it. Next, this piece of over-

Mr. W. Parkes, M. Inst. C.E.

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hanging arm as far as the line of the east pier; then removing the existing work. Then 300 feet of extension beyond the line of the north pier.—It is for the extra work at the pier head. Then I have deducted from the total of that the estimated cost of works by the sanctioned design, which would be suppressed, and the balance is 11½ lacs, nearly.

689. To carry out that work it would be necessary practically to close what will be the north-east entrance and re-open it again?—Yes, the estimate is based upon that; but I should say that since I made this plan a point, then I think would also occur to Sir John Coode, has occurred to me, that is, that that acute corner there would be a most intolerable nuisance, and my idea would be that it would be better to build a bridge across there, a strong staging of iron piles probably, so as to let the sea run in there, instead of mounting in that acute corner and overlowing the work in both directions, and probably preventing all access to the outer part of the pier even in moderately calm weather.

690. (*Sir John Coode.*) Have you taken into consideration the enormous strength of the stage that you would require to carry both the titan and the blocks?—I have not gone into the details, but I look upon it that that angle is almost a really fatal objection.

691. Surely that must be got rid of; that could not be allowed?—That angle?

692. This little *cul de sac* is what you mean?—Yes.

693. That must be got rid of?—That seemed to me to be the readiest way to get rid of it.

694. Cost what it may, that must be got rid of?—I will put it by the next meeting what the cost of it would be; in addition, but I do not think it would be really anything to affect the principle.

695. (*Chairman.*) You say that these figures are intended to cover the cost of a protecting arm of 300 feet?—Of a protecting arm of 300 feet beyond the line of the north pier, which is the length adopted by the Madras Committee.

696. Will the protecting arm extended from the designed line of pier make any additional objection to a north-east entrance, seeing that the sea face is concave?—Is an objection to a certain extent. I think all engineers try to avoid these concave lines, if possible, but a great many have not succeeded in doing so. There is a concave line at Holyhead, concave lines at the Tyne, concave lines at Marseilles, and at Alderney.

699. (*Sir John Coode.*) Might it not be met by an additional length of wave breaker, so that the wave breaker might take practically a straight line?—It would be an enormous width.

701. I do not mean the whole.—It would take off a little from it; and no doubt some additional width of wave breaker would be desirable there, if it is only for strengthening that part.

702. (*Chairman.*) Is it necessary, in opening the harbour at the north-east corner, to have the opening so far out that that concave surface becomes necessary; in other words cannot the protecting arm be carried on in a straight line from the original works?—Of course it might be done, and I have seen a proposal for it, but it would appear to me to be so very objectionable that I do not like to submit it as even a possibility.

703. From what reason?—It would make that so very much more confined than it is now as it stands.

704. (*Admiral Sir George Nares.*) And force ships into shallower water in rounding it?—Yes, it would be very little shallower. There is plenty of depth to spare.

705. Of course every sailor must be aware of the objection from the shallow water and room to turn point of view, but from an engineering point of view, is there any objection to carrying on that line straight and so avoiding the concave surface?—From an engineering point of view there is none.

706. Then what is your objection to it?—The objection is, that it would be such a very much more contracted entrance for a ship to make.

707. Would not that be met by making the entrance wider?—Yes, that might be done. Of course that adds to the work, but if that were the idea, I should be disposed to go a step further and bring it well in *here* (*pointing to the plan*), which I think would certainly have some advantages.

708. Then you are not disposed to entertain that idea of carrying it on straight?—There is no objection to it from an engineering point of view. My only reason for not carrying it on straight was that I certainly thought that there would be a serious nautical objection made to it.

709. On nautical grounds?—Yes, on nautical grounds.

710. (*Chairman.*) Has this alternative proposal ever been before you?—I do not remember seeing that straight line, but strictly speaking this entrance question has never been before me. It was referred at once to the Hawksbee Committee, and I simply assisted them in their inquiries.

711. (*Sir John Coode.*) You said you thought it would require two seasons to remove the work if it were decided to make the entrance to the north-east?—Two years. That is the least that I can contemplate.

712. I understood you to say that that was the least. Are you aware that some of the authorities at Madras have stated that one season would suffice?—I was not aware of it.

713. If it has been so stated, you do not agree with it?—No, I do not agree with that certainly. I should have no confidence in finishing it in two years even—that is four seasons really.

714. (*Chairman.*) Is there any alternative to the method on which you propose to work? Supposing the north-east entrance to be decided upon, is it possible to complete the sea face from the south side?—It would be possible to do so; but, to begin with, it would take double the time, because we could only work one titan instead of two.

715. In saying it would take double the time, do you include the time it would take to clear away the north-east entrance after the northern half of the sea face is completed?—Yes. I think I may say that the plan that I have proposed would be done, with the exception of clearing away the site of the new entrance, in three years. It would take double the time, according to that alternative plan.

716. In my question I did not except the clearing of the north-east entrance. My question was intended to provide that the north-east entrance should be cleared at the same time that the works of the sea face were being progressed with from the south side?—I think we might reckon upon doing 1,000 feet a year; consequently, in 15 months we should reach the southern boundary of the old entrance. In that 15 months I am quite certain that we should have done not much more than one-half the clearing of the new entrance; and then we should be unable to do anything more. By my plan we could work from one side or the other until we finished.

717. (*Admiral Sir George Nares.*) Then, in fact, there is so much work completed now at the north-east point of the harbour that there is practically no alternative plan to the one you have proposed?—Practically no alternative plan. The only alternative plan is manifestly inferior.

718. (*Sir John Coode.*) That being to leave open the two entrances for a period of a year, for a year and a half, or from one to two years?—Yes, from one to two years.

719. Would the harbour, under those conditions, be much worse than since the cyclone of 1881 as regards tranquillity?—It would make this difference in regard to tranquillity, that, according to my plan, we should be advancing both arms at the rate, say, of 1,000 feet a year. According to the alternative plan, we should be advancing only one arm at the rate of 1,000 feet a year.

720. Then would the existence of an opening at the north-east corner, simultaneously with the present entrance, be a very great objection, seeing that the tendency of the sea and the rollers is to run directly seaward and past the north-east entrance?—I think that a great deal of sea would come in at that north-east entrance until is has a covering arm—then it would be reduced, no doubt—and the two seas coming in at the eastern entrance and the north-east, and meeting in the harbour, would, I should imagine, create a confused sea that would be very dangerous.

721. Am I right in understanding that the worst local winds are from the north-east?—There is no doubt that those are the worst local winds.

722. Do they prevail very frequently, or not?—They prevail in the months of November and December. You will get that a great deal better from Mr. Lowe than from me; but I do not think that the seas from local winds are at all an important element.

723. They do not greatly disturb the water within the harbour?—No.

724. If that is so, does not that rather go to diminish the objection to the north-east entrance?—That is one objection that has been raised to a north-east entrance; but it is not the only objection, and it is not the one to which I should attach the greatest weight.

725. Yours being that of cost, I understand?—No, I think that the nautical difficulty is the main thing; and cost is also to be taken into account.

726. In reply to Question 214, you said that you consulted certain officers with regard to the bench mark, and that they could not give it. Do you mean that you consulted the officers attached to the survey?—Yes.

727. The officers who made the chart?—Yes; Jarrad and Faile. It was one of those, I forget which.

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728. Did they suggest that the bench mark had been obliterated? It is a strange thing that the officers who made the survey could not find their own bench mark?—The last inquiries, I believe, were made by Mr. Thorowgood, and communicated to me; and the result was that they could not clear up the discrepancy.

729. And they could not find the bench mark?—I presume not.

730. Do you assume that their depths were less than yours?—Yes.

731. To the extent of about how much; a foot, do you say?—I cannot remember the extent, but something like about a foot; a foot or a foot and a half. I spent hours in trying to get at it, but was obliged to give it up as a bad job.

Mr. GEORGE WILLIAM LOWE examined.

Mr. G. W. Lowe.

732. (*Chairman.*) You have been foreman of the breakwater works at Madras, have you not?—I have.

733. Are you still?—No, I left in August 1886 invalided.

734. How long were you employed at the harbour works at Madras?—About 11 years; ever since 1875.

735. Was that from the commencement?—From the very commencement.

736. Then you had every opportunity of watching the currents?—I had, and had to contend with them very often.

737. Had you any means of marking the rate of a current?—No, I did not do that.

738. At the pier end of the works were you able to work at all times as regards the current?—No; there were times when the divers could not stop down, and even when I had set my block, it would be apt to take the block round the corner, swinging from the titan; that was only at times, and, of course, I was afraid it would break the machine of the titan.

739. Were those at regular times; at regular seasons of the year?—No.

740. At irregular times?—At irregular times; that is why I could never account for them. At certain seasons, when they did come, they were at the north pier, and at other seasons they were at the south pier. When we could lower blocks at the north pier, and the divers could stop down at the north pier, it would happen with the south pier, but it never happened in both piers at the same time.

741. Was it not governed by the prevailing wind?—Sometimes there was no wind at all when these currents would take place.

742. Have you ever been able, in any way, to form an idea of the rate of the current?—No, I never did take note of that myself.

743. You have no means of saying whether the current was one, two, or three knots an hour?—No, I could not say that.

744. At what times of the year has the work been most interfered with?—From October up to January; that is at the north side, the north pier; and generally in July and August at the south pier; but in those months there is generally a ground surf on, all over, no wind, and that is when we had the most difficulty, when there was really no wind,—about July. There would be a heavy surf on then, without any wind at all.

745. That is during the south-west monsoon?—Just so.

746. (*Sir John Coode.*) Did the current extend far beyond the end of the work?—It did. We could see by where the coloured water would extend, and that was not very far out, because you could see from the coloured water how far the current would go.

747. How far out would you say that was, in yards?—I should say half a mile. I have often seen ships laying in the roads at their anchor; instead of laying with their head to the wind, as a ship should do, she would be laying in quite the reverse way.

748. (*Admiral Sir George Nares.*) Would that be affected by the tide?—By the tide.

749. Would it last for several hours, or only for a few hours?—That would last sometimes for half a day.

750. Then it might have been a tidal change affecting the main current?—It may have been so, for what I know.

751. (*Chairman.*) Was the work on the breakwater continuous, or were you obliged to remove your cranes at certain times of the year?—We never did do so until this year. We used to work all the year round with the exception of just about a fortnight in November.

752. It was never considered necessary to remove the cranes?—No.

753. Not even when typhoons were threatened?—No, we used to fasten them down for a fortnight; chain them well down to the Lewises,—to the blocks,—to the superstructure rather.

754. You are in the habis of diving yourself, are you not?—Sometimes. I did not go down very often in Madras, because we had a proper foreman diver there, specially for that, but often the divers were obliged to come up, the current was so great that they could not remain just on the face of the work.

755. You have heard of the proposal for opening an entrance at the north-east corner?—Yes, I have.

756. Do you know how far the reconstruction works have gone?—Up to the present?

757. Yes; with regard to the proposed opening?—They have gone, I should think, well up to the mark, so far as I can understand.

758. Just look at this plan (*placing same before the witness*). You do not know that the work at present is about two-thirds across the proposed opening?—I cannot say that. I never heard exactly what it was to be.

759. Allowing it to be two-thirds across, from your knowledge of diving operations would it be a very difficult business to remove all this work that has been placed?—It would not be impossible, but it would be very difficult.

760. And the operations would be very frequently interrupted by the state of the sea?—Yes. For one reason, all the base work is all complete there, and it would be very difficult to remove that.

761. That is the rubble base?—Yes, it is not impossible, but it would be very slow and very difficult.

762. Can you give any idea of the time likely to be occupied?—It all depends upon what appliances we have to remove it. It might be all crushed up to small stone and we might have some sort of a way of dredging it.

763. (*Sir John Coode.*) In the wave breaker which has been put down outside the site of the proposed opening, has there been put in any quantity of rubble between interstices?—No, not as yet. Nothing between the foreshore blocks.

764. The only rubble, in fact, then, is in the base?—In the base; the foreshore blocks are deposited on the top.

765. On the surface of the rubble base?—Yes.

766. When you spoke of dredging you did not contemplate removing the foreshore blocks, did you?—They will have to be removed first.

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767. But when you spoke of dredging you were then referring only to the rubble base, were you not?—Only.

768. Would it or would it not be a more difficult operation to grip the large blocks, either the foreshore blocks or the blocks in the superstructure below water, than it would be to release the gear when you had set them?—Much more difficult.

769. That is to say it is a totally different thing lifting a block from below water to what it is when the block is above?—Yes, really, it is not an easy matter; to grip it again is difficult.

770. You would regard that as a very serious operation in point of time and cost, would you not?—It is. As I say, it is not impossible, but it would be difficult.

771. Do you think you could give us any idea of the time it would require to move a length of about 500 feet?—I could not. I do not like to say a time, because we might be very fortunate in taking up a block, and it might perhaps take a whole day to get hold of one, the way they are put together. It is not like as if you could grip them.

772. They are lying at all angles?—At all angles.

773. And some of them are, no doubt, very much interlocked and interlaced with others?—Very much so.

774. So that it would require a far more powerful hold of the block to raise it and lift it out than to set it?—Yes, and for this reason, we would have to begin the back part of it. If we could come *this* way and tear it up it would be a different matter.

775. When you say "this way," what do you mean?—The blocks are laying at *that* angle, one against the other, so that if you could pick up in this way (*describing*).

776. You are speaking of the blocks of the superstructure?—Yes, they would be the most difficult ones to remove.

777. More than the wave breaker?—Yes.

778. You mean because of getting in at the joint at one side?—Yes, they are all stuck together, what with shell fish and one thing and another.

779. The interstices may be filled up, but surely there is no great cohesion between block and block by means of shell fish?—No, not by means of shell fish altogether, but with a little vibration they are rubbed in together. They work as much as a quarter of an inch.

780. I believe there were cases further in where they have actually worked four inches, have they not?—Yes.

781. Here and there, exceptional cases?—Yes.

782. Do I understand you to say that, as a rule, the blocks are rubbed in together as you describe?—They are. You find the centre joint, where the wall is actually two inches narrower than it was, instead of being 24 feet it is two inches less, and there the blocks are set like the teeth of a saw in the centre joint.

783. Then this wearing away has not been anything like an even plane, from your description?—No.

784. But so irregular that, in fact, they are toothed one into the other?—They are.

785. To what extent should you say that toothing takes place?—As the centre joint?

786. Anywhere?—From half an inch to an inch.

787. Is that the average?—A half-inch would be the average.

788. (*Admiral Sir George Nares.*) Is that the wearing away?—There is a vibration every monsoon that makes them work. We thought of pointing the centre joint this way (*describing*), but now they actually close up and work one on the other, and then they do not move afterwards.

789. (*Sir John Coode.*) Is that owing to the difference between the hardness of the cement and the hardness of the stone forming the concrete, or how do you account for it?—The toothing is caused by the stone. When it comes to the stone there it stops and wears a little into the mortar.

790. All the cement is worn away?—All the cement is worn away.

791. With the stone remaining?—With the stone remaining.

792. Consequently you get that toothing that you have described to us?—Yes. If it was an equal substance, of course it would wear smooth.

793. (*Admiral Sir George Nares.*) Is the outer wall toothed as well, or does that remain a clean face?—No, that is a clean face. There is no bond work. They do not move after the first monsoon.

794. (*Sir John Coode.*) You could lift with an ordinary Lewis above tide level?—Yes.

795. The difficulty you are anticipating is with regard to the blocks below low water?—Yes.

796. A great deal of blasting is done by boring from above the surface; do you think you could not jump holes into the blocks, and lift with a Lewis of the ordinary kind?—No, it would not be deep enough in concrete to do that.

797. Is the concrete so weak as that?—No, but you would have to get down at least two feet.

798. You can jump a hole 20 feet?—You mean just a round hole.

799. Yes, two feet in, and use an ordinary Lewis, a wedge Lewis?—That would have a tendency to tear away what we call the collar of the top. You could not get your wedge to bear at the bottom unless you have a patent, then you could not jump the hole to take that.

800. Do you think an opening of 500 feet in length could be cleared in two years?—I should think it might in two years.

801. Do you think it could be done in less?—I would not like to take it for less, if I were to take it; and then whoever did do it must have a staff of men who properly understood the work.

802. And appliances?—Yes. I would not like to undertake to take up that piece of work with natives.

803. (*Admiral Sir George Nares.*) Is that irrespective of the dredging away of the rubble bank?—Yes.

804. (*Sir John Coode.*) How many days in a year (supposing the wave breaker and the superstructure cleared), do you think the dredger could work there in removing the rubble?—Not more than six weeks.

805. Out of 12 months?—Yes.

806. Would that six weeks be at any particular part of the year?—That would be generally about February; beginning about February, then again in September.

807. Then you mean to say two periods of six weeks each?—Say two months out of the year, it would not be more than that.

808. Two months out of the whole 12?—Yes, out of the whole 12. There is generally a run-on of surf.

809. Under those circumstances, do you think divers could remove the rubble by filling into boxes, as we know has been done before?—They could do it. The face is not clean stone. It is partly crushed, and it would be very difficult for a diver to fill it.

810. Is is not only crushed, if I understand you right, but to a certain extent some parts are softened, and it is like rubble set in tough clay to a certain extent?—To a certain extent.

811. I want to know, is that so, because that is what I know of the nature of the laterite?—Some of the laterite is of that nature. Some of it is not so soft as that, but where there is a soft lump that goes away, and all the rest follows, of course.

812. Then that which softens acts as a sort of cementing material to the harder portion?—Quite so. That is why, if we could dredge it out after we got the blocks away, it would not be such a difficult job.

813. Let us be clear about this. You think there are not more than two months out of the whole 12 that a dredger could be employed in removing that rubble away?—No, I am sure of it.

814. That would be in two periods of about four weeks each; is that right?—About four weeks each; that would be February and September.

815. (*Admiral Sir George Nares.*) And in the other part of the year is there any place of shelter in the harbour where the dredger could remain?—Yes, either one side or the other, because if the wind is to the east the wall there gives great shelter, and if the wind is in the other monsoon that wall gives great shelter, except just when the cyclone comes on; it would be rather dangerous then.

816. But apart from a cyclone there would be shelter underneath the north-east corner or the south-east corner for the dredger?—Yes, good shelter.

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817. Can you give us any information about the direction in which the heavy seas approach the harbour; do they come direct from the east, or are they dependent upon the monsoons?—They are dependent upon the monsoons a great deal. In October and November they generally come away from the north-east, and in the other monsoon they generally come from the south-west, I should think.

818. South-west would be off the land, with a southerly monsoon?—Yes, but there are land winds with which we generally get the heaviest seas at the south pier.

819. But they must come in from seaward then?—They do, but a little on the angle. Although the wind is blowing right from the land, the sea comes in at that angle.

820. That would be from the south-east?—Yes.

821. When you said "south-west" you meant south-east, did you not?—Yes, I meant south-east.

822. We have been told that the waves are never more than about three points of the compass from east; that would be that they never come from south-east or north-east; you do not agree with that, do you?—The swell generally comes in from *this* direction, or *this*, on those two curves as a rule (*pointing to the plan*).

823. Would you think that it comes more than three points; that would be direct north-east, and direct south-east?—For two or three months it comes just on the north-east corner on *that* head, as near as possible. That is in October, and November, and December.

824. Then if an opening is made in either of the north-east corner or the south-east corner a heavy sea would enter, unless some protecting work was constructed in the face of it?—Just so. Of course if there was something outside to break it, it would not enter.

825. What was the height of the dock of the titan above sea level?—About 24 feet from the sea level.

826. Did the sea ever strike it?—I have seen it strike it twice.

827. But not during the ordinary monsoon weather?—No, not during the ordinary monsoon weather.

828. And could you work at the north-east angle during the north-east monsoon?—On certain days we could not.

829. Could you work at the south-east angle during the south-east monsoon?—No; when we could work *there*, we could not work *there*; and when we could work *there*, we could not work *there* (*pointing to the plan*).

830. Then during the southerly monsoon you could work at the north pier?—Quite so.

831. But during the northerly monsoon you could work at the south pier?—Quite so.

832. Can you tell us whether the Masula boats found any protection when the works were intact inside the harbour, or were they obliged to haul up?—As we went on after we got about 800 feet, we found they always had shelter from one side or the other, according to which way the wind was, without any surf at all, either one side or the other.

833. They always found shelter, except during a cyclone?—Quite so.

834. And then they had to haul up?—And then they had to haul up.

835. Were you at Madras when the harbour was completed?—I was, at least as far as the completion went.

836. And at that time there was good shelter for vessels in ordinary weather at one or the other side of the harbour?—Yes.

837. But the opposite side was always troubled with a sea coming in at the entrance?—Yes.

838. During the north-east monsoon was a steamer able to lie comfortably at the south-east corner of the harbour?—Not very comfortably.

839. During the southerly monsoon were vessels able to lie comfortably to the north-east corner?—Very comfortably.

840. They were?—Very comfortably indeed.

841. Then during the southerly monsoon there was shelter all over the harbour?—Yes, all over the harbour.

842. But during the north-east monsoon there was shelter all over the harbour except at the south-east corner?—Quite so.

843. Was the whole of the south side of the harbour exposed to the sea during the north-east monsoon?—No, not the whole of it.

844. A vessel could lie pretty comfortably in shore?—Quite so.

845. On the south side of the harbour?—Yes.

846. Can you give us any idea as to the height of the waves inside the harbour with the different monsoons; were they much higher in the north-east monsoon than the south-west monsoon?—Yes, they were higher in the north-east monsoon.

847. And about what height would they be at the end of the pile pier?—I have seen the highest there, when there has been a great surf on, with the exception of a cyclone. I have seen just the spray of the surf touch the floor of the iron pier in a cyclone.

848. (*Sir John Coode.*) That is about 18 feet above high water, is it not?—Yes; but the heaviest swell I have ever seen was all round the iron pier; in fact in the harbour, it has been, when there has been no wind on, what I should call a ground surf; that would be in about July.

849. (*Admiral Sir George Nares.*) That would be coming direct in from the eastward?—Yes, right in from the eastward.

850. That is the heaviest sea to which the inside of the harbour will ever be exposed, that which comes in from the eastward?—When there is what we call the ground surf on. When the ground surf is on, there is no wind at all.

851. But the ground surf you allude to is not dependent upon the monsoons?—No.

852. It comes in irrespective of them?—Quite so.

853. And in considering the tranquility of the harbour, we must put on one side the monsoon weather?—Yes.

854. In the ordinary north-east monsoon, how high would the waves be at the pile pier without any ground surf, the ground swell?—I should think about nine feet from the floor.

855. Even when the harbour was completed?—Not more than four feet.

856. Could an ordinary boat land passengers at the end of the pier, which appears to be in 3½ fathoms of water?—They land a little further up—about 50 feet from the T end. They could not attempt to do such a thing before the harbour was built.

857. Were you there when the works were ruined?—I was not. I was just home on two months' leave. It just happened when I was within a day's sail of Bombay, coming out again to finish the pier heads.

858. Then you did not see the surf in the harbour during the heaviest cyclone?—I was there during two or three heavy winds, but I was not there then.

859. But during those cyclones the works were not completed?—No.

860. (*Chairman.*) Supposing, in reconstructing the harbour, you change the position of the entrance; there are two suggestions here by Mr. Molesworth, one to the north-east and one open to the south-east, each with a covering arm; which would you prefer?—They would be both difficult. If a north-east monsoon was blowing the sea would come right in, and would be very difficult.

861. Then would you prefer to keep the entrance where it is?—I would, if you ask my clear opinion.

862. (*Admiral Sir George Nares.*) We are told that the easterly wind blows a very few days in the year. Can you tell us about how many days the very heavy easterly ground swell would be experienced that you have told us of?—That would be in July, but then I do not know that the ground swell comes when there is an easterly wind.

863. You told us it did not; it comes sometimes in calm?—Yes.

864. But about how many days in the year would the harbour be exposed to this heavy swell?—A month.

865. About 30 days?—Yes, about 30 days.

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886. And about how long would it be exposed to the north-east monsoon?—About three months—October, November, and December.

887. Then for three months there would be a sea coming in at the north-east opening, if one were made?—Yes.

888. As comparative to the sea coming in at the present easterly opening it would be much heavier, but would only come in for about a month?—That is all; but there are times that it comes in at the month when we get the south-west monsoon.

889. But have you calculated that in your estimate of 30 days?—Yes.

890. It would not be 30 days consecutively, but 30 days in the whole year?—Yes, 30 days during the year.

891. (*Sir John Coode.*) Would that swell last for a whole day, or two, or three or four days at a time?—Sometimes a week right off.

892. A week continuously?—Yes.

893. What then would you say was the rule. What is the average duration of that swell?—Mostly in July.

894. Is the harbour more tranquil now—I mean since the cyclone of 1881—than it was before you turned the corners with the north and south arm?—It is more sheltered now with the corners.

895. The point of the question I want to ask you is this, what is the effect of the now submerged portions; do they afford a considerable amount of shelter to the harbour, or do they not?—They do.

896. Have you had a dredger employed there at any time in the year?—Never.

897. There never has been a dredger?—We never have had a dredger.

898. With regard to the question put to you by Sir George Nares just now, do you think there would be risk to a dredger occasionally in that harbour?—In a cyclone, of course, she would be apt to go ashore, there is no doubt about it. Of course, when once the harbour is complete she would be sheltered.

899. Prior to the completion of the harbour there would be risk?—Yes.

900. Did the sea come in very large bodies over the work before the cyclone of 1881?—Sometimes very heavy.

901. Would green water rise high above the top?—Yes.

902. About how much?—I have seen it come over there, three feet of solid water from the north-east.

903. (*Admiral Sir George Nares.*) Is that in a monsoon?—Yes, when there was the least swell on.

904. (*Sir John Coode.*) In a cyclone?—No.

905. (*Admiral Sir George Nares.*) The ordinary monsoon weather?—Yes.

906. (*Sir John Coode.*) Would that last long?—No, that would not last more than 24 hours at the most. Occasionally, in fact, we could not get down for sometimes a day and a half or two days. We used to get down in slack time and make the titan fast at the north pier.

907. Was the effect of that to pour a considerable body of water into the harbour?—Yes.

908. Did that or did not, that create a current out of the existing entrance?—No.

909. The water was constantly pouring in?—It was, but it used to draw away a very little distance from the wall; it would not come over.

910. And the effect of the swell died away?—Quite so.

911. But did not it cause a current of water to pass out between the heads, that is the point; was there not a current passing out?—It would cause a current; then it would come round *that* way (*describing*), and so the south, and would go out at the opening.

912. Have you seen that?—I have seen a piece of wood floating round.

913. Did it pass out rapidly? At what rate should you think?—I should think at five knots an hour.

914. Did that go directly out to sea?—No, it would just go outside the pier head and take one direction or the other, whichever way the wind or current was going; but now, if I may speak again, the concrete blocks put down on the foreshore stop all that. Nothing comes over now.

915. (*Admiral Sir George Nares.*) And when the breakwater is raised another six feet it will be still better?—Much better. That will stop all that.

916. After the harbour is completed on the present designs you would suppose that no water would come over except during a cyclone?—Nothing would come over with it six feet higher, only in a cyclone.

917. In all ordinary monsoon weather the harbour will be quite tranquil, except as disturbed by the waves coming into the entrance?—That is all.

Capt. A. E. Barlow.

Captain ARTHUR EDWARD HARLOW examined.

898. (*Chairman.*) We are commissioned by the India Office to take the opinion of nautical experts on the question of the entrance to the Madras harbour. We have, I think, an opinion given by you in writing to Captain Taylor?—Yes, to Captain Taylor, on the 1st August 1883.

899. You have frequented Madras harbour, that is to say, the built harbour, have, you not?—Yes, I have been inside it, I think twice.

900. Not more than that?—No.

901. Do you mean when it was in its completed state, or during the whole time it was under construction?—Once when it was almost completed, and the last time there was a considerable portion of the eastern face washed away, in fact it was on a level with the water edge.

902. May I ask what ship you commanded at that time?—On the first occasion I was in there it was a vessel called the "Rosetta," on the last the "Paramatta," in August 1883.

903. Can you remember what the weather was when you visited Madras?—The last time it was in the south-west monsoon. The weather was moderately fine. There was a considerable run in the harbour.

904. Have you ever visited it in the north-east monsoon?—I cannot say that I have since the harbour has been completed. I have been many times in the roads, of course.

905. From a nautical point of view, the weather, generally speaking, in the north-east monsoon is worse than in the south-west monsoon, is it not?—Yes, I should say there was more swell—more sea.

906. More sea and more wind?—Yes.

907. In fact, what it takes the south-west monsoon eight months to do, the north-east monsoon does in about four; is that about the proportion, do you think?—I should not say so much as that.

908. Had you any difficulty in taking the harbour through the east entrance?—No, none whatever. The weather was quite moderate.

909. And there was not sufficient current to affect you?—No.

910. Have you ever seen much current at Madras?—Lying in the offing, six or seven or eight fathoms, at times, with the prevailing wind, there is a strong set.

911. With the prevailing wind?—With the prevailing wind. I could not say always, but frequently with the prevailing wind.

912. Can you remember ever lying across the wind and current?—Well, hardly; except at a time between the land and sea breeze setting in.

913. You said that on one occasion it was during the south-west monsoon you were at Madras, the last time, I think?—Yes; the last time would be in August. The south-west monsoon would be well in then.

914. And the other time?—The other time was, I think, in the north-east monsoon; about November or December, I think.

915. You had a pilot to take you in, I suppose?—Yes, one of the harbour officials.

916. And how did you take up your berth; you rounded to whichever way the wind might happen to be, always the weather side of the harbour?—Yes.

917. And while lying there, were you ever affected at all by the swell coming through the east entrance?—No, we moored, as well as I recollect. I forget whether there was a mooring buoy laid down or not, but we brought up with our own anchors and had a stern-fast.

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918. Were you affected by the sea or swell coming in through the east entrance?—Yes, there was a considerable disturbance of the water, much more than I should have anticipated.

919. But, taking it on the whole, were you able to carry out your cargo work better than out in the roads at the same time?—Hardly appreciably. Practically, to my mind, there was very little difference between the stillness of the water where we were lying and what we should have had in the same depth of water outside.

920. Do you think, from what you say you saw of the harbour when it was at its best, that was to say, when it was nearly complete, that you would have trusted your ship to ride out a cyclone in the harbour?—Certainly not.

921. So that that closes that question. You do not think that with the entrance where it was it could ever be safe to ride out a cyclone?—That never entered into my calculation. I never dreamed of such a thing. I say, taking into consideration the question of remaining in the harbour in a cyclone or with threatening weather, I think any man who has seen what a Madras hurricane is would be very reluctant to remain in a small enclosed space such as the Madras harbour.

922. With regard to the suggested—I can hardly call it proposed—entrance in the north-east corner of the reconstructed harbour, do you think that that would make any difference in your opinion upon that point with the east entrance closed, as to riding out a cyclone?—None whatever. I do not think, wherever the entrance was placed, it would make any difference in my mind as to remaining there to ride out a hurricane.

923. I suppose we may safely assume that with the south-west monsoon you would have smoother water in the harbour if the eastern entrance were closed up?—I should say so.

924. During the north-east monsoon do you think it would be smoother or otherwise?—I have some doubts about that. I am inclined to think that it would be smoother, because all my experience goes to show that the great body of the sea comes in from the eastward. It is a chopping sea. You get from the north-east quarter the local wind, but the great body of the swell comes in nearly parallel to the coast.

925. Is that constant?—Sometimes, when there is no wind at all, you get a very heavy surf coming into Madras.

926. Is that at a particular time of year?—No, I think you are liable to it at all times.

927. Then are you in favour of closing up the eastern entrance and opening one to the north-east?—I have been hitherto. Of course I do not know what the engineering difficulties are.

928. (*Sir John Coode.*) Put them aside for the moment.—I think it would give larger space in the harbour; a quiet harbour and a clearer space for vessels entering and leaving.

929. (*Chairman.*) What was the length of the "Paramatta"?—420 feet on her keel.

930. Will you place yourself in the position of the captain of the "Paramatta" to enter the harbour by the north-east entrance in a north-east monsoon, according to the design shown on that plan placed before you?—To enter north-eastward, I should presume there would be some object on the line of bearing by which to run in.

931. You would not think there was any greater difficulty in taking the harbour there than there would be at the eastern entrance?—I should not think there would be any more difficulty in taking the harbour there in such weather as I would take *this*. I mean to say, I would not attempt to take this entrance, blowing a heavy gale of wind, but in moderate weather I should not say there was any more difficulty with a steamship under good command to take *this* entrance than *that*.

932. Seeing you would have the wind under your tail, and that your ship would for a part of the time be partly sheltered by the breakwater, but partly exposed to the swell?—That would almost apply to coming into *this* entrance. You would have the north-east wind on your quarter there.

933. Yes, on your quarter.—And the breakers under the lee *here*. I do not think there is much more to be said there. I do not think the proximity of the breakers to be a source of danger in such weather as it would be prudent to enter the harbour in.

934. There is an alternative plan there shown by that red arm which tends rather in shore?—I should be rather doubtful about that.

935. Would that make a difference to you in turning in?—It would certainly contract the entrance very much.

936. No, it need not contract the entrance, it would bring you closer in shore.—It would bring you closer in shore.

937. And you think that even a short distance like that closer in shore would be objectionable?—Of course every few yards you come closer in shore is objectionable; but that arm would, no doubt, have an effect in counteracting the north-easterly swell; whatever that may be, but I should certainly prefer *this* opening, because it would give deep water and a clear lead into the harbour.

938. There is still another plan suggested, which you will see if you turn that page over. *That* entrance is to the south-east, and it is made more by the northern half of the eastern breakwater overlapping the southern.—Yes.

939. Would that commend itself to you at all?—Well, I should think that plan would also have the effect of rendering the water in the harbour more quiescent than it is at present by having the eastern opening.

940. I mean from the point of view of handling the ship. The worst weather, I suppose, taking it altogether, the strongest winds and the hardest squalls, you get from the north-east?—Yes, I should think so.

941. Would you think it would be better, from a seaman's point of view, to have the entrance from the north-east or the south-east?—I should think, of the two, the south-east would be the best, because there is no doubt the local wind and the surface disturbance of the water is greater from the north-east than it is from the south-east.

942. Of course there are other questions that enter into that; but I want to get the purely nautical point of view. Have you ever been able to land in your own boat inside the harbour except at the pier?—Never.

943. As far as you have seen of it, would it be practicable?—I do not think so.

944. At any time?—I do not think so at any time. It would be quite practicable for a ship's boat to land alongside the pier.

945. With the entrance to the north-east (say, the black design) it would still very much reduce, would it not, the best part of the anchorage during the north-east trade, seeing that you would have to keep the road clear for ships entering and leaving?—I should not think so.

946. Do you think you would be able to lie with safety under the eastern face?—I think so.

947. Your cargo boats would have to cross the line of rough water, would they not, to get to the shore?—Yes, possibly; unless in exceptionally bad weather, I do not think this would affect materially the landing or shipping of cargo.

948. Then you may say roundly that, from a nautical point of view, you are in favour of closing the eastern entrance and opening a north-east entrance?—Practically so.

949. (*Sir John Coode.*) Is your opinion very decided on that point?—Well, I have not any very strong views on the subject.

950. Supposing the cost of making the eastern entrance were something very heavy, what would you say then; do you think the improvement be such as to justify a very large outlay?—I do not think so.

951. When you spoke just now of your vessel being driven nearer the shore with the red design than with the black design, had you noticed that the head of the north pier, as it was proposed to be terminated, would still be in seven fathoms of water?—Yes.

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952. So that you would have plenty of water if you were driven down towards the head of the north pier?—Yes, you would have plenty of water to manœuvre in.

953. Is the character of the sea inside the harbour, when it is much disturbed, different from that outside? The sea outside being a long roll, how is it within the harbour?—It is more what sailors call a joggle.

954. Is it more difficult under those circumstances to take in and discharge cargo than in a roll; how is it with regard to the cargo boats themselves; do they work as comfortably with a sea of that nature, which you have just described as a joggle, as they would in the roadstead?—Oh, yes.

955. Quite as comfortably?—Quite.

956. But you do not think that interferes with the operations of loading and taking in cargo?—No, I do not, not more so than the roll outside.

957. (*Admiral Sir George Nares.*) As to the deflection of the sea, we are told that it is generally in a line parallel to the shore?—That is my experience.

958. With the north-easterly monsoon would the sea be directly in from the east, or would it be partly from the northward?—The heavy swell and rollers, I think, come mainly from the east; the top-breaking water, the surface water, would follow the direction of the wind.

959. Do you mean the rollers connected with the monsoon, or heavy rollers independent of any monsoon?—The line of surf which comes in independent of any monsoon. In fact, Madras beach is seldom without a surf, sometimes heavier and sometimes slighter.

960. When those rollers are not taking place at all, and the monsoon is blowing itself, in which direction would the sea be? Take the north-easterly monsoon, would it follow the line of the monsoon, or still be inclined to come in from the eastward?—My experience is it is more from the eastward. It does not follow the line of the monsoon exactly. The heaviest swell when it comes on the beach is very nearly parallel to it.

961. Are you talking now about where the surf breaks on the beach, or the sea that would be in eight or nine fathoms of water?—Well, I look upon them both as being very much in the same direction.

962. But still the north-easterly monsoon would bring in a sea from a different direction to the south-west monsoon?—Yes, no doubt.

963. Can you give us about how many points it would be, totally independent of any heavy rollers coming in from the eastward? In one of the papers from India it is stated that it is never more than about 30 degrees. Would you agree to that?—I was going to say that my experience is that in the long swell that comes in there is very little difference in the two monsoons in the swell that comes in from seaward.

964. I want to get the monsoon weather independent of the heavy rollers coming in from the eastward. We have it in evidence that the heavy rollers are estimated to come in, say, 30 days in the whole year, but the north-easterly monsoon lasts three or four months, does it not?—Yes.

965. Would you agree to adopt that estimate?—Thirty degrees of difference?

966. No, that we should have the north-easterly monsoon, say for three or four months, but that we should have, independent of that, a heavy rolling sea direct from the east for about 30 days in the year?—I have not been there frequently enough to be able to give a confident opinion upon the period; but, judging from the time of the monsoon, I should say so.

967. Then your evidence is that the heavy rollers coming in from the east ought to be guarded against, as far as the tranquility of the harbour goes, much more than the north-easterly monsoon seas that enter?—Quite so.

968. And as far as the tranquility of the harbour goes, it is more important to keep those heavy seas out from the eastward?—Quite so.

969. The heavy seas coming in from the easterly opening would disturb the centre of the harbour, both in the deep water and the shallow water, would they not?—Yes.

970. When the harbour is completed with wave breaker blocks and the breakwaters raised six feet, would you expect to find smooth water under one or other of the arms in all weathers except an actual cyclone?—I should think so, comparatively.

971. That is with an easterly entrance?—With an easterly entrance.

972. With an easterly entrance, would you, in the north-east monsoon, expect to find smooth water under the north-east end of the harbour; and with a southerly monsoon, would you expect to find smooth water under the lee of the south arm?—Well, my experience, of the harbour (which is not much), is, that there would never be absolutely smooth water in the harbour with the easterly entrance.

973. Never at any time of the year?—I do not think so; never, for instance, what would be sufficiently smooth to put two vessels alongside one another, or if it was ever contemplated to put a vessel alongside a jetty. I do not know whether that was ever contemplated.

974. In any part of the harbour you mean?—I do not think so.

975. But we are told that the whole offing outside Madras is perfectly calm for about two months in the year, without any breakers on the beach whatever. You do not agree with that?—I have never seen it myself under those circumstances. I have never seen it when I considered it would be safe to land in a ship's boat at any time of the year.

976. Could not we disembark from a boat on the south pier inside the harbour in the southerly monsoon?—I should say decidedly.

977. Then in the southerly monsoon there would be smooth water under the lee of the south pier?—There would still be a run, but nothing to prevent the boat coming alongside of the south pier and landing at steps.

978. Then, even with the southerly monsoon, the run coming in at the eastern opening will affect not only the north side of the harbour but it will affect the south side you think?—I think it will affect the whole of the harbour.

979. As to the tranquillity inside the harbour, you answered Sir John Coode that if there is a heavy expense connected with the change of opening you would be against the change?—I should. I do not think the amount of extra tranquility that you get would justify a very heavy outlay.

980. And the chief point of altering the entrance is as regards the tranquility inside?—Quite so.

981. Has the troubled sea that you have experienced inside the harbour been the sea that came in at the entrance, or was it the sea which came in at the entrance *plus* the water coming over the breakwater?—On one occasion that I have been there the walls were still almost standing level with the water, and very little would be coming over. The last time I was there no doubt it was increased by the water coming over. You could see nothing in many places between the rollers of the wall. There were gaps so deep that you could not see the remaining part of the masonry or the concrete blocks.

982. Then your actual experience has been that when the most troublesome sea was inside the harbour it was a good deal occasioned by the sea coming over?—The sea coming over.

983. As well as the seas coming through the entrance?—Quite so.

984. It is proposed to narrow the entrance 100 feet—from 550 feet to 450 feet,—which, of course, will lower the sea that enters the eastern entrance. Do you think that 450 feet will be dangerous for ships to take?—No, I should think not, not in any weather that it is fit for a vessel to take it in its existing state. I think 450 feet would be ample for it.

985. Have you ever seen the sea in the north-east monsoon coming over the north-east end of the harbour?—I cannot say that I have. My experience has been, since these works have been erected, somewhat limited. I have only been there occasionally—within intervals of two or three years, in fact.

986. With a north-east entrance, whatever sea there is from the north-north-east direction will affect the whole of the deep-water end of the harbour?—I have no doubt it will.

Adjourned sine die.

At the Board of Trade, Whitehall.

Friday, 13th May 1887.

MEMBERS PRESENT:

VICE-ADMIRAL SIR NOWELL SALMON, V.C., K.C.B., IN THE CHAIR.

SIR JOHN COODE, K.C.M.G. | REAR-ADMIRAL SIR GEORGE S. NARES, K.C.B.

MR. F. C. THOMPSON [India Office], *Secretary*.

Lieutenant-General R. H. SANKEY, C.B., R.E., examined.

Lieut.-Gen. R. H. Sankey, C.B., R.E.

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987. (*Chairman.*) Will you be so kind as to state what your appointment was in India; was it under the Indian Government or the Madras Government?—My appointment has been under both. I have been under the Government of India for 22 out of 38 years service in India, and, as immediately affecting the Madras harbour, I was appointed chief engineer and secretary to the Government of Madras (the Public Works Department) in April 1879; I resigned my appointment on the 17th September 1883. During that time I had necessarily to deal, among other subjects, with questions of ports and harbours, encroachments of the sea, &c., &c., all round the coast of Southern India, the Madras harbour being the most important of the works then under execution, and about a third finished. The Irish Board of Works, of which I am Chairman, has in charge five Royal harbours, and is now constructing 57 piers and harbours, many on the Atlantic seaboard.

988. Then the Committee may understand that you had no responsibility in connexion with the design of the Madras harbour?—None whatever.

989. And that you had nothing whatever to say to the position of the entrance as the works were originally carried out?—Nothing whatever.

990. When you first took up your appointment at Madras, did you form any opinion as to the part of the design which relates to the entrance of the harbour?—No, I did not, as I considered the whole design, as generally laid down in Mr. Parkes' scheme, to be beyond my criticism, but I had the question brought under my notice by a minute of Sir Andrew Clarke, then Public Works Member of Council of the Government of India, which I now beg to hand in to the Committee, dated 1879, and which opened up the whole question of the harbour entrance, and every other matter connected with the harbour. I have Sir Andrew Clarke's permission to place this before the Committee.

991. Were you in any way the superior of Mr. Parkes, the engineer-in-chief of the works, and was it part of your duty to criticise the work as it proceeded?—Mr. Parkes was made engineer-in-chief for the harbour works by the order of the Secretary of State, and was placed in a very independent position. At the same time, my own appointment being that of professional adviser on all subjects to the Madras Governments, I conceived that I was authorised, and in fact responsible, for every single engineering work carried on by the Government. Mr. Parkes took an opposite view of the question, and, at my solicitation, he referred the matter to the Madras Government, as both one and the other were necessarily in rather a difficult position as to responsibility. The Madras Government decided, that, as their professional adviser, it was my duty to lay every point before them, and to criticise, if necessary, anything that was done.

992. During the course of the works did you see any reason to form an adverse opinion to the entrance being on the eastern or sea face?—It must be remembered that the harbour was never severely tested throughout its construction from January 1876, till the time of the cyclone of the 12th November 1881, that is to say, it was not tested in such a manner as to show what the full amount of disturbance might possibly amount to, though, on various occasions, whenever there was rough weather, it became perfectly apparent that the harbour did not, from its deficiency in length as compared with its breadth, give the requisite tranquility inside. This is Mr. Stevenson's well-known formula:—

$$x = H\frac{\sqrt{b}}{\sqrt{B}} - \frac{\left(H + H\frac{\sqrt{b}}{\sqrt{B}}\right)\sqrt[4]{D}}{50}$$

Where
H = Height of wave at the harbour entrance;
b = Breadth of entrance;
B = Breadth of harbour at place of observation;
D = Distance from entrance to place of observation;
x = Height of residual wave at place of observation.
All dimensions in feet.

He observes that that formula is based on the assumption "that the waves after being reduced by lateral "expansion shall have time to sink and be afterwards "destroyed. But if instead of this they be reflected "back again towards the entrance, such returned "waves will destroy the tranquility of the basin and "prevent vessels from answering their helm when "taking the entrance." Adding that, "A harbour of "the same reductive power which is suitable for a more "sheltered locality may not therefore answer for a place "which is less sheltered, *unless it be made on a larger "scale.*" Were the formula to be applied without the reservation as to insufficient length, very false conclusions would result. Thus, were the harbour long enough in Mr. Stevenson's sense, a wave 22 feet high, entering the harbour would apparently sink to nearly 8 feet at the head of the screw pile pier 1,000 feet from the shore line; one of 18 feet to 6¼; one of 12 feet to a little over 4 feet, and so on; Mr. Parkes, having adopted the formula without the necessary reserve, made the following remarks in a lecture delivered in Madras in 1880, viz.: "Through that "entrance (550 feet wide, in 48 feet of water) alone "can any wave enter, and when it enters it will expand "over the whole width of the harbour spending itself "as it does so, until it becomes insignificant; with "the prevailing seas from north-east to south-east, "which enter the harbour very obliquely, it is "expected there will be very little movement inside. "With the comparatively rare seas from the eastward "there will be a little more commotion, but not enough "in any case to affect ships, though it may some-"times retard landing and shipping cargo for a day or "two." I will immediately show that Mr. Parkes subsequently saw reason to modify very materially his opinion as to the reductive effects of his harbour on the waves coming in through the present entrance, and in the meantime I can only express my conviction that in rough weather the waves, owing to the relatively short length of the harbour, are not much, if at all, less in height than those outside on the beach, north and south, but that from deflections within the harbour and reflections from the shore the surf waves assume a different and more difficult form to deal with in landing goods or passengers.

993. Will you please add whether that was when the harbour was complete?—Before the completion of the harbour.

994. (*Sir John Coode.*) But at what stage. It is very important to know that. What distance were the ends of the piers apart at that time?—It was I should have said when the harbour was practically complete, in November 1881.

995. Then, if I understand you rightly, these remarks that you make would apply to the harbour immediately before the cyclone of November 1881, with the entrance about 550 feet wide; is that so?—Yes.

996. (*Admiral Sir George Nares.*) Then it is not only your conviction, but it is a statement of fact that the waves did not decrease in height to any appreciable extent after entering through the entrance of the harbour?—In rough weather, certainly not, in my opinion. With the long unbroken roll of the surf, when unimpeded by the harbour walls, the masoolah boats

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used to come in with one or two swelling movements, whether the rollers were high or not, and were not subjected at such times to the same buffeting as they now receive in rough weather.

997. (*Chairman.*) Rough weather when landing within the harbour on the beach?—When landing within the harbour. But to make this point more intelligible I must turn to the action of the waves during the cyclone of 12th November 1881, which destroyed the seaward arms of Mr. Parkes' breakwaters, and to the evidence which has been lately afforded, in discussing the relative powers of the cyclone of 1872 and 1881. Mr. Parkes in his letter of the 9th March 1886 observes that "A rough "test is afforded by the action on the planking of the "screw pile pier, 17 feet 6 inches above mean sea "level (he is remembered 2,500 feet within "the harbour mouth). This planking was torn up in "1876, in 1874, and again in 1881, but it is uncertain "whether, on the last occasion, the effect of the harbour "works would be to reduce the waves at the site of "the pier (as I have no doubt was the case over the "area of the harbour generally), or to aggravate them "by the confusion which would be caused by their "rolling in over the piers as well as through the "entrance. The end of the pier is just outside the "line in which the first breaks of the waves occurred, "and the height there was no doubt abnormally "raised."

998. Do you say that the planking of the pier was washed up during the cyclone of 1881?—The planking of the pier was washed up on all three occasions, the cyclone of 1876, the cyclone of 1874, and again in the cyclone of 1881; and, as I have every reason to believe, this happened like the other accidents as lately reported by the Master Attendant, before one bank had fallen from the place theretofore. My friend, General Cadell, was on the end of the pier on one occasion when they were torn up. In 1881 it was exactly the same, the tenth being apparently that the length of the harbour being insufficient, the waves assume a pyramidal instead of the ordinary form. In immediate connexion with these observations I will take those to which the Madras Government in their letter to the Government of India, dated 14th March 1887, draw special attention, —direct statements made by the Master Attendant relative to the cyclone of the 12th November 1881, which though very material towards forming a proper opinion of the character of that storm, have hitherto escaped notice. The Master Attendant observes "the mighty swell" (he is speaking of the effects of waves of translation in contra-distinction to merely wind or oscillating waves) "thrown off by the storm comes in far greater "velocity, its motive power supplied from a distance "never weakens, and on all the occasions the port has "been visited by them they have reached the platform "of the iron pier which stands 18 feet above mean sea "level. This was particularly noticeable in the rough "weather that caused the destruction of the outer "walls, for, although the arms were finished to their "(full) length," (he omitted the word "full," but such was the case,) "the swell came in, as I have described, "and all the cargo boats in the place were wrecked, "the beach ravaged, the low level jetties—then in course "of construction—utterly swept away before a block had "fallen from the walls." This should certainly settle once for all every argument based upon the mis-application of Mr. Stevenson's formula as to the reductive power of an entrance sufficiently wide for ships (which, as declared absolutely by all masters of vessels who were asked for their opinion, should not be less than 550 feet) in a comparatively short harbour like Madras. I may add that, as is well known, not only were the steam hopper vessels the "Hobart" and "Salisbury," with their fine old master and a large number of the native crews lost in the storm, but the occurrence was rendered particularly and as well as instructive from the fact that, in all probability many of the lives would have been saved were it not for the dangerous sea set up by the presence of the harbour walls. None of the Catamaran-men (probably the most expert and daring fishermen in the world) could be induced for any sum of money, freely offered, to face the raging surf, and even the crews before the vessels broke up, their assigned reason being, as I heard at the time, that the cross seas set up by the harbour walls were quite beyond their experience, and that they were powerless. The confusion was frightful to witness in the tumbling surf, the waves immediately beyond assuming much more pyramidal forms than ordinarily observed. To my mind, therefore, it is incorrect to say that relief from the dangers or disagreements of the surf is the main plea which can now be advanced as a sufficient reason for the Madras harbour.

999. Do you think that a masoolah boat could have been launched outside the harbour, or a catamaran, during this heavy sea?—Masoolah boats cannot be launched from anything in the shape of a harbour wall, or anything of that sort.

1000. I mean from the beach outside?—The catamaran-men will go through almost anything in the shape of surf.

1001. I mean during the time that they said that they were unable to do so inside the harbour, could they have done so outside?—Captain Taylor, who is now coming home, will give you direct evidence, and will tell you that the catamaran-men assured him that they would have been prepared to undertake this duty had the harbour not existed. Any one who has seen those men in a storm would know that they will face almost anything so long as the rollers come in in the regular swelling way in which they do, ordinarily. Here (*pointing to a plan of the harbour*), from the deflection of the harbour wall and from the harbour being too short, a perfect state of chaos is created during storm.

1002. (*Admiral Sir George Nares.*) Were vessels wrecked outside the harbour in that same cyclone, and was life lost?—There were two sailing vessels outside the harbour. They either took the first signals and got away or they rode it out. I forget exactly which.

1003. There was no loss of life outside the harbour?—No, none outside.

1004. (*Sir John Coode.*) Can you tell us in what particular part of the harbour those two hoppers were that were wrecked. It is rather important to know that?—On the north side, in line very nearly with the outer extremity of the screw pile pier. I think they was as nearly as possible the position (*pointing to the chart*).

1005. Then they were, so to speak, under the north arm?—They were not far from the north arm.

1006. At about what distance?—They were about 1,500 feet out, or perhaps less.

1007. From the shore?—About that.

1008. And how far southward of the north arm roughly?—I should say about 100 yards.

1009. And were they in this very confused sea which was deflected from the north arm?—The whole was converted into a boiling surf.

1010. Did this "boiling pot" (as it has been described) extend across the whole width of the harbour?—Yes.

1011. Was the break on the beach within the harbour, between the two piers, of a different character from that outside, north and south?—I certainly considered it so. The workmen were engaged upon those two side piers. The screw pile pier is 18 feet above mean sea level, and the side piers were made only 7 feet (*pointing to the chart*) in order to assist the lighterage going on from the different vessels. We intended to have constructed two of these low side piers, and would have in fact, carried out four, but the cyclone upset the whole idea. These two piers were torn to pieces in the storm.

1012. Then the masoolah boats could not launch from the beach within the harbour, if I understand you rightly?—The catamaran-men could not, much less the masoolah boats.

1013. I think I understood you also to say, in answer to the Chairman, that they could have put off from the beach north or south of the harbour?—They might if clear of any abnormal action.

1014. (*Admiral Sir George Nares.*) Had there been no harbour there, could they have put off?—The catamaran-men might have done so. I do not say the masoolah boats; the catamarans are different; they are composed simply of logs.

1015. But the masoolah boats could not, you think?—The masoolah boats could not. They cannot face a storm in any case; nothing beyond a moderate one. It is only the catamaran-men that can do so. The catamaran-men will face almost any storm.

1016. You referred just now to some late evidence with regard to the relative force of the cyclones. In what document is that evidence contained; where will that be found?—The late evidence I was alluding to

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was the statement made by the Master Attendant that all the damage he relates occurred before a single stone fell from the harbour walls. Mr. Parkes' argument, as I have mentioned before, was that this confusion was apparently to some extent produced by the fact of the several breaches on the seaward faces having occurred before the destruction of the side piers, &c., and a great tumbling sea coming in through them. Captain Taylor has now produced evidence (and I can quite bear him out in it) showing that this actually occurred before a single block fell on that celebrated 12th November.

1017. (*Chairman.*) Then on that point, when all this damage occurred inside the harbour, to use a nautical expression, were green seas breaking over the whole length of the eastern face?—Yes. I saw the waves breaking over in green seas. The mean sea level was raised two feet by the storm, so that this (*pointing to the breakwater on the chart*) was just about a couple of feet you may say above.

1018. What I mean is this, the sea was not breaking first on the harbour walls, but it was rolling right over?—Yes, the seas were rolling right over. The seaward arms and the titans were destroyed later on. I was not present when the titans were struck, as I had gone to my office. They were struck, I think, about 11 o'clock in the day. The green seas, they say, reached the platform of the titans, and there must have been, I should think, 24 or 25 feet of green water. I am not certain about that, as I did not see it myself.

1019. Are you thoroughly acquainted with the proposed restoration works?—I know the extent of them, but I, of course, have not been able to follow them since I left Madras.

1020. I mean are you familiar with the plans?—Yes, I know the plans.

1021. Do you think that the proposal to raise the wall from 6 feet to 12 feet with the additional protection outside, of the wave breaker formed of random blocks, would be sufficient to resist such a sea as that which wrecked all the small craft in the harbour during the cyclone of November 1881?—I would certainly bow to the opinion of the eminent engineers who decided that matter.

1022. It is your opinion we want, because you were on the spot and saw it?—I expressed, I think, the feeling of all the local engineers in Madras in the proceedings of the so-called Madras Committee, and I think they were quite prepared to accept the opinion that such would be the case; that is to say, that the protection would be sufficiently strong, and that adequate shelter would be given behind those walls; that is to say, they would break up the whole of the seas. What water tumbled over would be merely productive of good. The seas nearly always come in with their crests parallel to the shore, no matter what the direction of the wind. Only a little "spillage" takes place in reality over these north and south piers; what water comes in helps to clean the harbour by the outward tow—nothing more. To show the amount of water which came in over the side walls during the cyclone, two masoolah boats having been wrecked and driven there, were taken by the current clean out of the mouth by the heaping up that took place inside producing a strong outward tow.

1023. (*Sir John Coode.*) Where were they lying?—I believe they were *here* (*pointing to the chart*).

1024. Nearly opposite the end of the jetty; about how far from the shore?—That I cannot exactly say. Captain Taylor will be able to give you the facts as regards those masoolah boats. It showed the piling up of the sea inside,—there was afterwards a regular race through the entrance.

1025. (*Chairman.*) In view of your opinion that the proposed reconstruction works would be sufficient to break up any probable sea, would leaving the entrance in the same position as it is now affect your opinion?—No; I have argued that leaving the entrance in the present position creates all the difficulty. Were this entrance closed my contention is, of course, that the harbour would be rendered "still."

1026. I think I must take you back again a step. Supposing that to have been closed during that cyclone, and the seas breaking over the wall, as it existed then, to a height of 24 feet (we will subtract the 6 feet for the wall and call it, in round numbers, 20 feet), would not that amount of water that came over have caused the damage that occurred, do you think?—No. The cyclone-generated wave is a wave of translation, as was well recognised at the time, affecting the water to a depth of 48 feet, and which, moving with a tremendous velocity, came through the entrance and gave an impulse to everything inside the harbour. Had the movement been broken up by a bar across the eastern mouth it stands to reason that none of that propulsion would have communicated itself to the water in the harbour; that, in fact, the waves which would have come over these sea arms would have had no further propulsion left in them. They would tumble over as water into a reservoir which was becoming fuller and fuller every moment, and the propulsion could not by any possible means have extended beyond this particular line (*pointing to the plan*). I may lay myself open to the charge of presumption in venturing to question the soundness of the opinion on one point of the very eminent members of the Home Committee, but so much is at stake that I have no other course than to state my views on the subject frankly, though with the utmost deference. The Home Committee, in giving their reasons for adhering to the original view of the reconstruction scheme (see their report of 12th March 1884), observed that "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 "from the latter; and we think that prudent commanders on these occasions would prefer getting out "to sea to remaining inside the harbour." From the direct experiments made by Mr. Stevenson with his marine dynamometer we know that the average results of wave action for the six winter months at Skerryvore and Tyree gave the blow as equal to 2086 lbs. per square foot, and the maximum, at the first named place, as equivalent to no less than 6,083 lbs., or nearly 3 tons. At the Bell Rock the result was 3,013 lbs.; and at Dunbar the astounding amount of 3½ tons per square foot. There can be little question that, with the centre of a cyclone passing (as it did on the 12th November 1881) south of Madras, the harbour works would be assailed not merely by oscillatory waves, but by a wave of translation, the whole mass of water in its full depth moving forward with tremendous velocity and power, producing effects which, in all probability, would quite equal those given above by Mr. Stevenson. Now, when we consider that every master of a vessel would, on the storm warning being given, send down all top hamper, and make everything snug, if he intended to remain in harbour; and above all that, the wind in no cyclone storm in Madras has been shown to exercise a greater pressure than 50 lbs. per square foot, I must submit that, however we may estimate the surfaces exposed to the blows and the respective leverages exercised by these forces, the action of the wind cannot come into serious comparison with that of the waves. Once, in fact, the cyclone-generated wave is barred by closing the eastern entrance, it would practically matter but little with good screw pile moorings how the vessels were assailed by the tempest; their hulls and cargoes would apparently be safe, as was clearly the opinion of Mr. Bateman. If you do not object, I will read Mr. Bateman's opinion.

1027. (*Admiral Sir George Nares.*) What date is Mr. Bateman's opinion given, is it before or after the works?—It was before. It was when the design was originally submitted to him for his professional opinion by the Secretary of State for India.

1028. He is there giving his opinion before the works were completed, I think?—This is before they commenced the work. Mr. Bateman's opinion as consulting engineer when Mr. Parkes' plan was referred to him was as follows: "The breakwater, though the "top be only 3 feet 6 inches above high water, will "very effectually stop the progress of the driving "waves and will afford material shelter within the "harbour. It will not prevent the water rolling over "in heavy seas, but the destructive effect of such "water will be destroyed and no injurious wave can "be prepagated within the space of the harbour." Then he continues "The water within the harbour in "all winds, however high, will be comparatively quiet." Mr. Bateman seems, like Mr. Parkes, not to have sufficiently taken into account the relative proportion between the length of the harbour and its breadth, but the effect is clearly that the destructive action of any wave of translation would be absolutely stopped if the barrier were there. No matter how low or how high no forward movement would be propagated inside the harbour.

1029. (*Chairman.*) In fact, that the shipping or small craft inside the harbour during that storm suffered

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from what is called the "fetch" of the sea and not from the rough surface?—The "fetch," as I understand it, generally applies to merely oscillatory waves, but the "fetch" in this case has relation to the particular position which Madras occupied with regard to the central path of the cyclone. The centre line passing south of Madras, the wave of translation was generated along the whole northern fringe of the cyclonic movement, and produced this particular character of wave. That is Mr. Molesworth's argument, and, I confess from my own slight knowledge of the subject, I believe it to be correct.

1030. But is it not within your experience that the waves on approaching the coast assume a direction parallel with the coast?—Yes. As appears from Sir Andrew Clarke's minute there were several direct experiments made with reference to the movement of the crests of waves, and he showed (or rather Colonel Thomason who carried out the inquiries) from photographs taken on the sand, that the maximum angle of waves under any direction of the wind never went beyond 30 degrees with reference to the line of shore.

1031. (*Admiral Sir George Nares.*) Although the wind might be how many degrees on that occasion?—That was the maximum effect, no matter what the direction of the wind.

1032. (*Chairman.*) That was the object of my question. The harbour works or the entrance to the harbour would be assailed from the same direction, no matter what the wind or the sea might be at some distance outside?—Even when the wind is blowing off the shore.

1033. In all cases?—Even when the wind is blowing off the shore the seas invariably tumble in perfectly, or alinoes, parallel with it. That is the normal action. Sir John Coode could tell you better than I that such is the general action of the sea.

1034. (*Admiral Sir George Nares.*) Was Mr. Bateman's opinion given in connexion with an opening on the east side of the harbour, or would it be enclosed?—Mr. Bateman was referring to Mr. Parkes' general scheme, of which the opening to the east was part. That was before the Secretary of State sanctioned it.

1035. Then in fact Mr. Bateman accepted the opening as it is now?—Mr. Bateman accepted the opening, but did not sufficiently make allowance, as I venture to think, for the harbour being too short to reduce the height of the waves. The only point I wanted to bring out with reference to Mr. Bateman's observation was, that the movement of the wave of translation would not be communicated to the harbour if a sufficient barrier existed.

1036. (*Chairman.*) You have quoted Mr. Stevenson two or three times. Does he not lay down as a maxim that the opening should be on the sea face of the harbour?—Mr. Stevenson particularly says, in his opinion, that the tranquillity of a harbour depends upon the relative widths of the entrance and the relation between the direction of the entrance and that of the line of maximum effects.

1037. (*Admiral Sir George Nares.*) By your experience, do you agree with Mr. Stevenson's formula being correct as to ordinary waves?—The only large harbour, of which I have sufficient practical experience is that of Kingstown. Its length on the western breakwater is, as you are aware, much greater than at Madras. We call four feet at entrance a pretty high sea. Sometimes the waves have gone up to about six feet at the entrance. If I had his work here for reference I could show that his formula has been found to apply very exactly, because it happens that in Kingstown harbour there is a very much greater length than at Madras.

1038. Not "very much"?—George Rennie, when he proposed Kingstown harbour, never intended that there should be a 750-feet wide entrance.

1039. I was just coming to that. You practically agree that Mr. Stevenson's formula may be taken?—Yes, if all the conditions are observed.

1040. Does Mr. Stevenson allude to cyclonic waves; that would be waves of translation, as you tell us, affecting the sea to the depth of 48 feet?—No, I do not think he applies his formula to that class of wave.

1041. Then, in this case, Mr. Stevenson's formula would not apply at all?—I do not think so. I have not sufficient experience as to that.

1042. That was your evidence practically?—I do not think that his formula would apply.

1043. (*Sir John Coode.*) Had Mr. Bateman ever visited Madras when he gave the opinion which he did on the works?—I do not think so. There were three points put to him, and that was one.

1044. You say there were three points; will you tell us what they were?—The first was whether the proposed method of constructing the breakwater, as described in the report dated the 4th November 1873, affords promise of stability; the second was whether the obstruction to the littoral currents offered by the breakwater is likely to cause an accumulation of sand, and if so, within what period such accumulation is likely to impede the entrance of the harbour; the third question is whether the proposed harbour being closed by breakwaters only 2 feet 6 inches in height above high-water mark, and having been 150 yards wide exposed to the sea, would afford sufficient protection to the shipping moored within it during the prevalence of high winds blowing from the shore.

1045. (*Chairman.*) In view of the proposal to narrow the entrance from 550 feet to 450 feet, would that, in your opinion, materially affect the waves that proved so dangerous to Madras harbour?—No. Looking at the waves and taking Mr. Stevenson's formula for oscillatory waves, it was shown by Mr. Molesworth in a comparative table, that the difference due to the diminution of 100 feet in width of entrance would only be one foot in the height of the waves at the end of the pier (that is 1,000 feet from the shore).

1046. (*Admiral Sir George Nares.*) One foot extra?—They would be one foot less in height—that was the deduction; but my argument depends more upon the wave of translation, and that the admission of this class of wave at all is utterly destructive of tranquility in the harbour.

1047. That one foot less was one foot in four of five feet, was it not?—Yes, about that.

1048. (*Sir John Coode.*) Your idea is, if I understand you rightly, that the waves are propagated, or were propagated, through the entrance of 550 feet, right down to the shore, and in a most dangerous way?—Yes, that there was a reflex action from the shore, and a deflective action from the sides which produced a complete "boiling pot" in the whole harbour.

1049. Which deflected action do you think was the most objectionable of the two, that from the sides, or that from the shore?—That I could not say.

1050. I take your own words, but I should hardly expect much of the reflex action from the shore out in the body of the harbour. I can well understand the reflex action immediately opposite the walls, transversely, that is, from north to south, or from south to north, according to which arm it might be deflected from; but can you speak within your own knowledge of having seen a reflex action from the shore, extending out into the body of the harbour towards the entrance?—I cannot speak very absolutely. I was not myself present when the cyclone was at its maximum, but what I mean is this, the harbour was filling up every moment, piling up the water all along the beach, and there were resistances established along the base of the harbour. There was an obstruction, as it were, along the shore line which was cut into all along.

1051. Now, if I understand you aright, instead of there being a sloping sand beach along the shore, between the two piers, the beach had been cut away and undermined to some extent, and left a vertical face?—That occurs to a great extent in every cyclone. Along the east coast the action of the cyclone is to cut away, perhaps, as much as 200 feet in width of the sand, and establish a bank, which is afterwards laid down again.

1052. What height of vertical face would that leave?—It might leave a vertical face of possibly as much as six feet of sand. The foreshore is washed away, and in the reflex action the seas tear away the sand, and carry it out to sea. I have seen the sea, on one occasion, muddy out to apparently eight or nine miles.

1053. (*Sir John Coode.*) Did you see anything of that sort prior to the breach taking place?—The shore was all being eaten away when I last saw it, in fact, the moment a cyclone commences that action sets in.

1054. The point I am anxious to arrive at is this: was there anything like a vertical face of six feet established along the shore, between the piers, before the breach took place?—There certainly was action of this character, but I will not say what was the precise effect at any particular point.

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1055. Some feet; quite an appreciable height?—It was shown by the breaking up, as Captain Taylor says, of the small side piers they were constructing. Everything was torn to pieces ashore. It might have worked back into the buildings, had the cyclone continued a sufficient length of time.

1056. This is very important, because it seems to clear up what I could not understand before, that is, this reflex action from the shore. The fact appears to be that this beach being undermined left a vertical face of something like six feet, and this was for all purposes as regards disturbance analogous to the piers themselves, so that it was a square box, as it were, with the undulations of the disturbance reflected from every side, certainly from the shore as well as from the two works themselves, because usually we find that a sloping beach has the effect of absorbing the wave; so it would, *here*, so long as it remained; but I learn now for the first time that one of the first actions of the cyclone has been to claw down the sloping beach and leave a vertical face. It has actually carried the sand away from the sloping beach, still further undermined the shore, and left a vertical face of four, five, or six feet, as the case may be?—If you do not object, I will read one observation on the subject about the storm that took place in 1807. It does not directly bear upon this question, but indirectly it does so.

1057. Is it authentic?—It rests on the highest authority. And is from a letter addressed by the late Captain C. Biden, master attendant, to the Secretary of the Military Board, dated Madras, 18th June 1851:—"Paragraph 16. As a remarkable effect of the great "force and power of the ground swell in this road-"stead, I may call the Board's attention to the follow-"ing occurrence, as published in the Asiatic Annual "Register for 1808, pages 128-9, to which I myself "was an eye witness, as I was living in quarters on "the north beach during the whole of one of the "most violent hurricanes that ever assailed Madras, "viz., on the 11th December 1807:—'The sea rose "'much beyond its usual height, the surf reached "'Messrs. Harrington's on the beach, and by its "'violence exposed four feet of the foundation of the "'house; one side of the adjacent building, the Naval "'Office (where I was residing) is much damaged, "'the Company's rice go-downs were forced open and "'much of their contents washed away. The sea rose "'close to the ditch of the fort, and the surf dashed "'with violence over the ramparts. The counter scarp "'at the north-east angle gave way, and the water "'poured into the ditch at every rising of the surf. "'The bastion at the northern extremity of the Black "'Town wall gave way, and two guns were dismounted "'into the sea, &c. Some idea may be formed of the "'strength of the current and force of the surf from "'the circumstance of a large portion of the ribs of "'a ship, supposed to be the 'Fairlie,' which was "'burnt in the roads in 1799, were thrown ashore "'close to Mr. Parry's go-downs.'" This shows the erosive action along the shore during cyclones. Fort St. George at Madras was threatened, and the sea face portion of it was rebuilding when I went out to Madras in 1848. The necessity for that rebuilding arose from that erosive action.

1058. Then is there combined with the action of the sea a long shore current taking the scuff away?—I do not think currents affect the matter much, because the wave of translation comes in the direction of the path of the cyclone, generally normal to the shore line, and for the time, at least, effaces, as I conceive, all long-shore currents.

1059. I thought from the motion of your hand you were meaning along shore, and I gathered that there was a current?—Oh, no.

1060. (*Chairman.*) Does not the ordinary deposit of sand compensate for the undermining in exceptional cases?—The moment the cyclone is over, then commences the normal action of the north or south currents, according to the monsoon in which it takes place. The sand travels chiefly from south to north, and there is an infinite amount of it. It re-establishes the old shore line before very long.

1061. Then within your experience the shore line, except where it is affected by the harbour works, has not materially altered?—No, within my own experience it certainly has not. It has been one of the duties of the Public Works Department for very many years to maintain the line of foreshore at Madras by a series of groins, and I should wish to allude to that fact afterwards, if you would allow me.

1062. (*Admiral Sir George Nares.*) Is this six feet vertical wall of sand above high water or below high water?—It would be close to high water or above it, I should think.

1063. Rather above it?—I should think it was.

1064. It would be well inside the breaking seas?—The sea establishes its own breakwater as it were. It cuts into the sand and leaves a somewhat perpendicular bank which it is constantly undermining.

1065. But there would be a line of three or four breakers outside it?—The breakers go out to eight or nine miles nearly in a severe cyclone. It was something awful in the storm of 1856, which I had to weather out at Ennore. I could see from the top of my house the surfs breaking out any distance on the horizon.

1066. Inside the harbour how is that beach. How does that beach attain its natural slope again after the cyclone?—It would attain its natural slope by the ordinary re-wash that takes place inside the harbour. Nothing would be brought from the outside to the inside to re-establish the beach slope, but there is a constant variation going on within the limits of the harbour. At one time more would be pulled off *here* as it were; at another time, *there*.

1067. What part of the pier was destroyed. Was it the inner part or the outer part of the deck of the pier that was washed up?—It was immediately at the "T" head—that is the outer extremity, a thousand feet from the shore.

1068. Then the deck was not affected farther in?—No, I do not think so.

1069. We have been informed that the sea did not break at the outer end, it broke just inside. Was the deck washed up before the sea broke?—That I cannot tell you as I was not out on the screw pile pier during the cyclone.

1070. Was the deck washed up outside when the sea broke?—I cannot tell you the particulars.

1071. (*Sir John Coode.*) Then although this vertical face would be established would it extend to any depth below water, so that it could affect the character of the reflex wave?—I think the character of the reflex wave is certainly affected, the impact taking place against this constantly increasing height.

1072. I will put my question in a simpler way. Is there any large body of water that strikes this vertical face. Is it merely the crest of the wave or a large body of water that actually meets the vertical face on the shore?—There is an enormous body of water, and it is a regular "boil."

1073. It is not merely the crest of the breaker that strikes the underpart of the foreshore, but that there is a not inconsiderable proportion of the mass of water which strikes the vertical face and causes the rebound that you describe. That is the point I want to be clear upon?—Yes.

1074. That is what you think the rebound from the shore is due to?—I think so.

1075. (*Chairman.*) I think so far as we have gone we may sum up your opinion in this way, that with the harbour reconstructed on the proposed plan and the eastern entrance closed it would be a secure anchorage for ships in any weather?—I am only able, of course, to give the reasons which enable me to say so on higher authority than my own.

1076. But you have been on the spot a good deal, and we wish to have your own opinion?—I cannot help thinking that as the closure of the eastern entrance would stop all movement of the wave translation it must *de facto* make the harbour a secure anchorage.

1077. That is your reason in fact for proposing it. You propose to make a safe harbour by that means?—I propose to make it the safe harbour originally sanctioned by the Secretary of State.

1078. (*Sir John Coode.*) You mean, I suppose, the safe harbour that the Secretary of State intended it to be?—I mean the safe harbour sanctioned by the Secretary of State on the professional opinions given him. He says the sanction was regardless of expense, or practically words to that effect.

1079. (*Chairman.*) Having closed up the eastern entrance, where would you propose to open up a new entrance?—If I had ample means, I would without

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hesitation close the eastern entrance and open one both north and south in the manner proposed by Sir Andrew Clarke.

1080. Do you mean north-east and south-east?—Yes, north-east and south-east, very much in the manner proposed by Sir Andrew Clarke in his memorandum. I have conditioned my answer by saying "if I had ample means."

1081. To commence with that part of your answer which proposes the opening of an entrance at the south-east corner, have you taken into your consideration the movement of the sand on that side of the harbour works?—Yes I have. I have taken it in this way; there is nothing as far as we now know to show what will be the time required for the sand to advance to the end of the south pier.

1082. I think we may as well say here that we have evidence that within quite a short time a sand bank has been forming at the south-east angle?—There is a bank forming?

1083. You are aware of that?—But that cannot be shown to be connected with the ordinary motion of the sand along the shore. That must arise from some different cause. What I mean is that the advance shown by the low-water mark on the accumulations to the south of the harbour has apparently been less pronounced as the water deepens, and I think it requires a great deal to prove what will be the character of that advance. It is quite conceivable that the advance may go on in future in a very much smaller degree than we have been hitherto acquainted with; for instance, at present the action only extends back south. I will say, for a mile, and there is no reason whatever to show that it will advance 50 feet a year seaward over the 1,500 feet now remaining to the elbow of the south pier. It may take quite a different mode of action. For every sensible advance seaward the accumulation may extend south for another mile, or even two miles, or three miles until at last a complete *régime* is established. There is nothing to show now that that action may not thus gradually diminish seaward, and perhaps in a hundred years the accumulation possibly reach not more than halfway up to the elbow on the south pier. That accumulation of sand may go on south possibly for a distance of 20 miles, and gradually establish the regime in the mode of advance. It may probably become very much less, as time goes on, but if it became dangerous nothing would have to be done but what the Madras engineers did long ago, viz., put in a series of rough groins along the shore, and compel the sand to deposit itself at any place required. The whole of this action might be stopped now by doing nothing, more than putting in rough stone groins, which cost but little to make. In fact, with the knowledge we possess of maintaining the line of foreshore by means of rough groins, there is nothing to show that the elbow of *this* pier would not be reached for the next 100 or 150 years or more.

1084. In fact that the sand might be arrested before it reached the pier?—Yes, I think so. I would not answer for that opinion being absolutely correct, but I know what effect the old groins had along the shore of Madras, and it is astonishing what can be done in that way.

1085. *This* plan (which represents the latest soundings taken) shows a tendency of the sand to move outwards along the south face of the south pier; do not you think, supposing the sand to have a steady tendency in that direction, that the projecting arm you have made to cover the southern entrance would arrest the sand and form a bank where you propose that the mouth of harbour should be?—As I have before stated, I think the action of the sand could be much arrested by means of rough groins extending along the shore to the south; and if any tendency of that kind occurred these would, to a great extent, if not entirely, check it. Moreover, it must be borne in mind that by making the arrangement for a south-east entrance with a covering groin, a *still* harbour would thereby be created, giving you the means of dredging, which probably would suffice to keep the harbour clear. No dredging can, of course, now be thought of in the present disturbed state of the harbour. A dredging machine now would simply be laid up and never used; but with a still harbour you have got everything then in your hands. You may keep the harbour clear, you may increase its extent by 40 acres now with valuable mooring places—you may do anything, in fact, the moment it is still. If ever it should occur that the sand overmastered you, and you are not able to carry on your dredging operations, and you are not able to arrest the sand by any and every means, the alternative remains of closing the south-east entrance, you have still got your north-east entrance open. My proposal is to have two entrances, one of which if, after a lapse of a century, you are deprived, would still leave the other string to your bow—the north-east entrance.

1086. Is it or is it not the case, looking upon the southern arm of the harbour in the light of a groin, that the deep water decreases inside the harbour?—I am not aware that the water inside the harbour is decreased in depth. I have never heard of its being decreased.

1087. The question I put to you was, is it or is it not?—Of course, I cannot absolutely say, but all the proof that came before us when in Madras was certainly to the effect that no change had taken place.

1088. But taking into consideration that the worst winds are from the north-east, should you be inclined to confine yourself to an entrance in the south-east corner alone?—I have always understood that the worst seas were from the north-east, which, I think, was the statement of the Madras Committee, and not the worst winds.

1089. From a nautical point of view, the heavy north-easterly squalls are said to render more difficult the making of an entrance at the north-east corner. Under those circumstances, should you be disposed, supposing it to be possible, to arrest the sand clear of the harbour, to trust to a south-east entrance only?—I should never, under any circumstances, trust to a south-east entrance only, from the fact of there being the contingency that the sands may advance on that side. I only advocate it as an additional advantage to Madras to have it, but the north-east entrance is the *sine qua non*. As regards the difficulty, from a nautical point of view, of making a north-east entrance, the Harbour Master at Madras has expressed exactly the reverse opinion.

1090. We will come to the north-east entrance. We are at the south-east entrance now. The water having shoaled at about the position where you put the south-east entrance from 7 to 6½ fathoms, and there being also the probability of its still further shoaling, would it not add to the difficulty of forming a ship into the south-east entrance. Would it not limit the manœuvring space for a ship, and render it more difficult for a ship to take the harbour from that side?—The question, of course, turns upon whether the shoaling will go on there at a greater pace than your means of dredging is enabled to overcome. That the dredging operations could be undertaken with the shield also I would propose for the northern entrance I think must be admitted, as the harbour would then be still, and it would merely be a question of means whether you would be enabled to keep that open or not. What the progress of the shoaling alluded to may be, of course I do not know, as I have not had any information about it. I would also like to add that, by opening a south as well as a north-east entrance, the current from south to north, sometimes said to have a velocity of 4 feet a second, would have an effect in scouring the sand in suspension, right through the harbour from south to north.

1091. Would there not also be the danger of a certain proportion of that sand remaining in the harbour and depositing itself where it found still water?—That comes back again to the question of dredging, as I mentioned before. It is the same question as we have at Kingstown harbour. We are constantly dredging there, and we find are able to keep it down completely.

1092. Throughout the whole area of the harbour?—No, a certain portion of it—any portion which may be required.

1093. It may prove the forerunner of a bank?—My contention is that with a still harbour you can dredge, as you have complete shelter; but you cannot attempt to do so otherwise.

1094. Limiting the question to a single entrance, what would you say?—Limited to the one entrance, there is no question, in my mind, whatever about the north-east entrance being the one.

1095. (*Admiral Sir George Nares.*) How far south of the harbour has the beach been affected up to the present time?—Up to the end of 1883, which was my own time, I think I may say it was affected to a mile or a mile and a half.

1096. A long way south of Fort St. George?—Yes. It was affected down to about the Senate House.

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1097. Along the whole extent of that beach the high-water line has advanced eastward?—Yes, it has advanced more and more, according to its proximity to the harbour.

1098. (*Sir John Coode.*) What length are these groins that you put out to the south that you described just now?—The Madras beach in olden times has given an enormous amount of trouble to preserve, and there were groins put at intervals along the whole length. Every one of those, until a short time ago, was bare on the north faces, though arresting sand on the south faces. From the accumulation of sand, however, they have disappeared, and are now completely buried. They were rough laterite groins.

1099. If they have been completely buried, as I gather from your reply, the advantage could only have been a temporary one?—They are buried simply from the advance of the foreshore all along under the accretions that took place from the harbour works—not otherwise.

1100. Since the operation was carried out?—Yes.

1101. Do you think you could succeed by groins of an ordinary length in arresting the progress of this sand towards the north, bearing in mind the distinction between the action of groins in respect of shingle and of sand, because the sand is in motion far and away beyond the line of beach, whereas, in the case of shingle, it just moves up and down within the tidal range, and not to the full extent of that, as a rule. I am only putting this in order to ascertain what your view is as to the possibility of stopping the sand?—I can only answer according to the facts. If I had an opportunity I could show you, by the plans, (I think, certainly, by writing to Madras), that the whole of the fort, and the town itself, was considered so much in danger that the officers of my own corps were for years engaged in establishing these groins; and that by these groins they completely restored the line of the beach, increased it, and, in fact, re-conquered all the ground that had been carried away, and re-established the whole of the old line of beach.

1102. What you are contemplating with regard to these groins is, to my mind, a very large operation, stopping the whole travel of the sand along the beach. I am a little apprehensive whether you could succeed in doing it?—I quite admit, of course, that it is a matter of expense, but it was not, to the best of my knowledge, found expensive or difficult to preserve the beach in that way. I suppose there must have been preserved at least two miles or two and a half miles of beach—re-conquered from the sea by means of those rough groins.

1103. That was done within your own experience?—It was part of the duty of the Public Works Department, before the commencement of the harbour works, to keep those groins in order and look after them. They were established to save the fort and the town, and were always kept in repair.

1104. (*Chairman.*) Then we had better take the question of the single entrance and the advantages and disadvantages of the north-east entrance. We will suppose that the south-east entrance is considered unadvisable on account of the very doubtful, not to say threatening, action of the sand, and we take into consideration a north-east entrance instead of the present one; do you think that it would give any great advantage in the way of smoothness of water in the harbour to make an opening at the north-east corner without a protecting arm?—There can be no question that the longer you make that protecting arm the more protection will be given.

1105. I mean to say you would not make the opening without the protecting arm, would you?—No, certainly not.

1106. Does the form of the protecting arms proposed in *this* plan recommend itself to you?—That was the form proposed by the Madras Committee, of which I was president. There was an objection raised to that, namely, that with the waves coming normal on to the re-entering portion of the curve there would be a "boil" established.

1107. That is to say, the outer portion of the curve?—Yes, but as was shown afterwards, there is no reason why the curve of the protecting arm should not be made flatter as it were, by putting a greater amount of material and straightening the outward wave breaker; or, on the other hand, with a very slight alteration it would keep the line as nearly as possible straight. It was a mere question of how to manage it so as not to bring it too far in. I think that the arm proposed by the Madras Committee may be a little too short, and that Mr. Molesworth is right about that. I would rather take his or Sir John Coode's opinion about that than my own. Unquestionably it might safely be carried perhaps more in that way (*describing*), and arrange the rubble so, so that there would be no great "boil" at the slightly re-entering angle.

1108. You think that an opening there is free from any objection, supposing there to be no other, as regards sand?—Yes, I think decidedly that that would be the case, and that were it otherwise, or were the sand accumulations even to approach to this outer south-east corner, the remedy then would be to go seaward with the south arm and stop it for ever by keeping the breakwater on that side always in advance of the sand accretions.

1109. The balance of the nautical opinion that we have heard as yet is against the north-east entrance, as being a dangerous one for a ship to take during the north-east monsoon and in squally weather, the principal objection being that it would be impossible to go slow into the harbour; that to keep the ship under command with the wind blowing in gusts astern or on one quarter, and the sea on the beam, it would be necessary to keep the engines going, and that inside the harbour there would not be space enough then to bring the ship to safely, also that to give the ship necessary room for bringing up you would have to sacrifice a large part of what would be, in the north-east monsoon, the safest and most sheltered part of the harbour. Have you taken these points into consideration in forming your opinion with regard to the north-east entrance?—First, as regards the seamen's opinion, we had, in Madras, practically, three sets of opinions, one, I think, in the year 1879, when a number of masters of vessels protested against the general scheme of the harbour, and latterly, after the Madras Committee sat, all the leading captains who came into the harbour were asked to state what they thought about the scheme of the north-east entrance from their own nautical point of view with the plans before them.

1110. We have a number of those opinions. We have also had some evidence from captains?—They one and all stated their entire concurrence in the advisability of the change of the entrance to the north-east angle. The Harbour Master and the deputy Harbour Master of Madras stated: "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 the 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 which attend the entry of large steamers (many of them over 400 feet long), even with the present width.

1111. As far as you are aware there is no objection, from a nautical point of view, to a single entrance in the north-east corner?—I never heard any nautical opinion of a different character.

1112. And with the entrance in the north-east corner and the eastern entrance closed, you believe that that would be a safe harbour in all weathers?—I have shown that the maximum force on a sailing vessel in a cyclone is that of the wave of translation, and that being cut off, my conviction is that the force of the wind, which never reaches more than 50 lbs. per square foot, cannot or should not in any way interfere with the safety of the vessel, although it might to some extent damage its rigging and hull. The cargo I believe would be perfectly safe.

1113. In taking into consideration the force of the wind, will you consider the action of the wind in the event of a centre of a storm passing over Madras harbour, where, after a short period of calm, it shifts from one point to directly the opposite, would this not be liable to pile the ships up on each other?—The scheme made out for screw pile moorings in the Madras harbour was to have afforded safe mooring for 27 ships, I think (I am speaking from memory merely), with arrangements to allow of their swinging.

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1114. That scheme of moorings was never carried out, I think?—One-half or one-third, I think, of the moorings were brought out in 1881 and they had screwed down some, but after the storm everything came to an end, I believe.

1115. Then you would prefer two openings, north-east and south-east?—I think the two are worth a trial, that is my own impression, but that the north-east entrance is a *sine qua non*.

1116. (*Sir John Coode.*) When you say two openings are worth a trial, have you taken into consideration the fact that to make an opening at the south-east would be a very expensive operation?—I have taken into consideration the opinion of the Secretary of State in sanctioning the harbour.

1117. That is before it was commenced?—When the scheme was sanctioned originally.

1118. I am speaking now of what would be necessary to create a south-east entrance, seeing what work has been executed?—The value of Madras harbour from its Imperial aspects, and, in fact, from its position as a harbour of refuge, I consider, myself, worth three or four times the amount that it has cost; and the Secretary of State entered upon it in that consideration, for he sanctioned it without reference to expense. I will read the words, if you will allow me.

1119. Scarcely to be measured by money?—In conveying sanction for Mr. Parkes' scheme, the Secretary of State, in a despatch of the 11th March 1875, after reviewing the scheme in its financial aspects, observed: "But the question is too large to be dealt with only "upon financial grounds. Many human lives are "sacrificed in the tempests which annually ravage the "Coromandel coast, and it is probable that a large "proportion of these might be saved if the vessels "which are now sacrificed in the roadstead could seek "the shelter of a harbour." But over and above that there is the great consideration that Sir Andrew Clarke has raised with reference to Madras as an Imperial harbour, which seems, to my mind, to be of even greater importance; and that is fully explained in the Minute of Council which I have laid before the Committee.

1120. Does Madras harbour partake of the character now of being valuable as a harbour of refuge?—The early history of India shows the value that Madras would have been as an Imperial harbour and one of refuge.

1121. "Would have been," you say; but you do not consider that it is so now, because we are told that vessels go to sea, more or less?—I am speaking of the Imperial aspect as a shelter for transports, ironclads, &c. With all the historical information we have before us, it is evident that Madras in time of war with a maritime power ought to play a very important part.

1122. You are speaking now of Madras harbour as it should be?—As it should be.

1123. Are you aware that some of the gentlemen who gave their opinions at Madras as to this north-east entrance have since altered their opinions?—I believe they have altered their opinions, but I should think that that would only take away all the credit due to their opinions one way or the other.

1124. That is as it may be. The question is whether second thoughts may or may not be best. I am not doing more than trying to come at the value of those opinions?—That of course the Committee are able to judge of.

1125. (*Admiral Sir George Nares.*) Then your opinion is that if the opening is left on the east side of the harbour, the harbour will be perfectly useless in a cyclone for either large ships or small ships, that is to say, that it will not afford them shelter?—I am not only certain that it will be useless but absolutely dangerous, and its existence now, according even to Mr. Parkes' own showing, prevents sailing ships venturing inside at all. He states so most distinctly. He says that steamers have to keep their fires up, that sailing vessels must remain outside, that the harbour authorities and the observatory authorities must be kept on the alert night and day, and be subject to a degree of alarm that is unfair to place upon any human being. They have to give much earlier storm warnings than they ever did before, as admitted by Mr. Parkes. He says, in paragraph 64 of his letter of 21st August 1884: "It must be admitted that in one respect a ship is worse "off in the harbour than anchored in the roads outside. "She must put to sea at an earlier stage of the warning "for bad weather, as the confined space increases the "difficulty of manœuvring the ship with a rising wind "and sea setting probably from different quarters."

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"It has sometimes been asserted that the harbour is a trap from which escape "would be impossible." I can recall myself one letter of the captain of the P. and O. steamship "Pekin," who distinctly stated that he never would take his ship in, as it would simply end in her being smashed up with all the other ships inside. Mr. Parkes proceeds: "It "might be so" (that is to say, it might be a trap) "once "in 10 years if the commander of a ship and the whole "staff of the Marine Department and the Meteorological "Observatory were simultaneously to neglect the most "ordinary and well known precautions, but under "existing conditions such an idea is inconceivable." But he omitted to think that after all these are human beings, and that Master Attendants and Observatory people cannot be kept constantly on the alert to such an extent looking out for premonitory symptoms of cyclones at a much earlier date than would be the case if the harbour were entirely open. They have to judge from symptoms which have not sufficiently developed themselves, and as a fact, the ships in Madras were sent to sea on five different occasions without there being any results whatever. No bad weather occurred, and they need not have left the harbour at all. That happened simply from the presence of the harbour. Mr. Parkes states so himself. I take it from his own statement.

1126. (*Sir John Coode.*) Within what period were these five occasions, did they extend over a series of years?—No, they occurred apparently within a short period.

1127. (*Admiral Sir George Nares.*) Mr. Parkes' remarks, that you have alluded to, would not apply to the present scheme in which the walls are heightened, a wave breaker added, and the entrance narrowed by 100 feet, would they?—Mr. Parkes had that scheme before him when he wrote those observations in 1884.

1128. If the eastern entrance is left in the harbour it must be sheltered in some way to afford perfect protection in a cyclone, inside?—Yes.

1129. If the north-east entrance is opened, do you think sailing vessels will then use the harbour?—Certainly.

1130. But they do not use the harbour now?—They cannot do so in any doubtful weather. You will be able to get from the Master Attendant how often they have been able to do so. I am not able to say myself.

1131. Does the Master Attendant or his deputy, to your knowledge, actually conduct the ships in and out of the harbour, or do pilots do so?—I think that it is the duty (as stated in the report) of the deputy Harbour-Master.

1132. If you do not know the fact, that we can get from some other source?—I think it is the deputy as on his authority a matter about the berthing of the ships in the harbour is mentioned in the Committee's Report.

1133. We have been speaking altogether, or mainly, about the entrance, and about the harbour being a trap, and not fit to moor t vessels in a cyclone; we will put aside the idea of a cyclone, and consider the harbour in connexion with the ordinary monsoons; with an ordinary monsoon, if the eastern entrance is left open, would vessels be able to land and discharge their cargoes inside the harbour in reasonably quiet water?—As far as the ordinary quiet period of the year is concerned, the landing of cargo, is no doubt greatly facilitated by it; but in rough weather it certainly is not in my opinion.

1134. Then in an ordinary monsoon a considerable sea comes in at the eastern entrance?—Yes, in rough weather.

1135. And enough to affect the ships?—Enough to affect the ships.

1136. Is not the probability that with the north-east monsoon there would be a more sheltered position under the north-east side of the breakwater, and that with a south-east monsoon it would be a little quister under the south-east side?—Yes.

1137-8. Then in connexion with the entrance, we have got to consider, not only the cyclone wave, but also the

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monsoon sea?—I take everything as being ruled by the effects of cyclonic waves. That is the only point I have looked at as being a certainty with which you have to deal. A chain is always tested by its weakest link, and the cyclonic wave is the weakest link in this "chain."

1139. In the north-east monsoon, would not the waves entering through a north-east entrance affect all the deep water part of the harbour?—I assume they would not affect the harbour at all, because the crests of the waves, certainly as far as we know, come in, as a rule, parallel to the shore, and would not propagate themselves inside the harbour.

1140. We were told that they were deflected 30 degrees from the parallel line?—I am not at all sure that that occurs during cyclones from the wind veering, I think, myself, that during cyclones the crests of the waves would be nearly or quite parallel to the shore line. The crests may assume that angle of 30 degrees with a long continuance of northern or southerly winds, but in cyclones, my conviction is that the seas come in parallel with the shore.

1141. Keeping to the monsoon, we have been told that the north-easterly monsoon sends in the heaviest sea on to the Madras beach, and that that is deflected about 30 degrees from the parallel line. Would not that enter the north-eastern entrance?—Not if the shield were carried out a length of 600 feet, as was advised, and as Mr. Molesworth and other authorities in the Government of India considered necessary.

1142. But by laying off an angle of 30 degrees with any north-east opening, we have still presented about 300 feet to the direct action of the north-easterly sea; it would affect the harbour to that extent, would it not?—Yes, it would affect it. Taking the entrance at, say, 550 feet, I suppose not more than half of that would be open.

1143. There would be an opening the same as there is an opening now at the eastern entrance to the monsoon waves?—Yes.

1144. Although if these monsoon waves are at an inclination of 30 degrees, we do not get the whole breadth of 550 feet disturbed?—My answer has reference to moderately rough water. It has nothing to do with the action of cyclones, and therefore the disturbance would be small. It is very much less, of course, and is not connected in any way with the wave of translation.

1145. Then that brings it down to this, does it not, that when we consider the evidence we should consider it practically in connexion with the cyclones, and not in connexion with the monsoons?—Entirely.

1146. Then, if the entrance is made upon the north-east side, you look upon the harbour as really a harbour of refuge in all weathers experienced at Madras?—Yes.

1147. (*Chairman.*) I think we now come to the last phase of the question that is referred to us. *This* plan represents the present state of the works. The rubble bank, as you are aware, is being very much increased in width, and the new easterly arms are being run out in a new line inside the wreck of the old arms, so that the wreck of the old arms should form a breakwater to them. In the case of the north-east corner the rubble bank is complete, and the stonework has been carried out for about two-thirds of the distance which would become the north-east entrance, supposing one were to be made. In case of the entrance being made *there*, the present entrance to the eastward must be kept open till these works are so far completed, that is to say, to the position of the present pier heads; after that is done *this* north-east entrance would have to be cleared away, and as far as I am any judge, that would be a very considerable work. Can you give us any idea at all of the magnitude of such a work, and of the cost of it. When you consider that I think I may say the whole of it would have to be done by divers, and that while that easterly entrance is open no dredging is possible, because there would be no safety for the dredger inside the harbour; have you taken into your consideration at all the time or the money that it would be necessary to expend in order to open that entrance at the north-east corner?—No, I have not, because I was given, in a general way, to understand that so long as the question was in any degree open as regarded the entrance, that those portions of the work would not be re-established in such a form as to lead to any extraordinary expense being incurred afterwards. That is a matter for the engineering staff on the spot. All that really could have been required would have been a means of communicating over the breached portions at the elbow, in order to complete the outer arms and form the communication, but I certainly was not prepared to face the question under these circumstances. However, supposing that those works are carried out to the extent stated now, it will necessarily add sensibly to the cost, should the eastern entrance be closed. There can be no question that it is practicable to do the work. I have no hesitation at all about that, and believe it would be perfectly practicable.

1148. Do you think that it affects the question at all?—Yes, as a question of money. For instance, as regards that point that you mentioned, of not now being able to dredge, it is clear that if the north-east arm were completed, the works might then commence in the formation of the protecting shield to the north-west, about 600 feet or more as the case may be; and after that has been completed, then the removal of portion for the new entrance might commence. *That* angle would not be exposed to the same turbulence, and there would be means, no doubt, of picking up the blocks and removing them, breaking them up, probably by dynamite at first, and then dredging them out, or by grabbing them.

1149. I take it that the blocks do not present the greatest difficulty. If I am right, the rubble base would present the greatest difficulty?—The rubble base, no doubt, would be a difficulty, but need only be dredged to 35 feet below mean sea level. It could be dredged out, because the shield having been completed that portion of the harbour would be entirely under protection.

1150. Then with regard to carrying out the works over that part which you eventually mean to convert into an entrance, could you do with very much less than the present means of carrying the ways, and the present ways for carrying the stone out to the north-eastern arm?—I do not quite understand the question.

1151. Two suggestions have been made. One is that ways should be carried out on piles sufficiently strong to carry the titan. The other is that the wall should be completed as at present designed, simply with a view to carrying the material out for completing the outer arms, and then taken away?—That, I think, is certainly what I should have expected.

1152. So that it could hardly have been left incomplete, except by an equally expensive process of building up ways on pile piers, could it?—I think a process might have been adopted of a temporary character, which would have enabled the titan to have been taken out and kept supplied with blocks. I do not know now whether they consider the titan safe in a cyclone. That seems to me to be perhaps a more practical question than any other.

1153. The titan can be run in, and is in, I believe, at the present moment?—Yes, that is what I mean. We will suppose the protecting spur carried out; the titan will be on the north arm; you could run her back then over this; but if so, you will have then to look to the titan on the south side to complete the closing of the present entrance. She would be safe there no doubt.

1154. We want you to thoroughly appreciate the difficulties arising from the present state of the works and not of the design of the works, and to say whether or not it affects your opinion as to opening an entrance to the north-east?—I should like very much to get Mr. Thorowgood's opinion upon the subject. I believe myself that the titans were not overthrown in the cyclone till the blocks to which they were anchored went; and that being the case, it might be possible, to secure the titan on some portion of the work. If that were the case I do not see (though I admit there is a great difficulty) that it ought not to be beyond arrangements which it could be quite feasible to make That is would add to the expense I quite admit.

1155. But you have not calculated that?—No, I have not. I was not aware, in fact, that the work had been carried out in *this* manner, because I was under the general impression that particular care would be taken not to prejudice this question of the entrances in carrying out the new work.

1156. Then I will ask another question, please. Seeing that the work is so far carried out, would it prejudice the question of a north-east arm if it were to be completed on the present proposed plan or scheme of

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reconstruction?—I think it is still a question of money only.

1157. What I mean is this: that as the eastern entrance must be left open (we will say till the north-east arm is completed, and till the north-east entrance is again re-opened), seeing that the rubble bank is already there, would an extra third of the stonework being completed now prejudice the question in the future?—Looking to the great issues at stake, I do not think it ought to be a question of money within reasonable limits. Looking at it in that light I consider that it ought to be done, and that it ought not to prejudice the question.

1158. (*Sir John Coode.*) Then I gather generally that in your opinion the perfecting of Madras harbour, which you consider the making a north-east entrance would effect, is not to be gauged from a money point of view, or have you drawn any limit. Supposing one were to ask you now, what would you think it worth in money to make the entrance now to the north-east, what would you say?—I would put it even in a broader light. I would ask what is harbour of safety worth at Madras? And I would say that it is worth any money up to two or three millions sterling. I will give my reasons in this way: first, with reference to the point of saving life and property; secondly, as regards the great Imperial interests at stake requiring a harbour of refuge or a war harbour for the British navy; and, thirdly, the necessity for establishing communication with the tidal canals north and south of Madras, into which will in future flow nearly the whole trade of the coast, and which cannot be carried out in any satisfactory way unless the eastern entrance is closed, and Madras made a still harbour.

1159. What becomes of that trade now?—It all has to be transhipped in carts. Mr. Parkes has suggested that the difficulties may be got over by means of a harbour 10 feet deep for small craft, up to a 100 tons, to the south of Madras, in the reclaimed ground. He has also drawn attention to the necessity of a boat harbour at the south-western angle of the main harbour. Neither one or the other of those can be kept open unless the eastern entrance is closed. Sand must accumulate about the entrances to them, no matter what work is carried out.

1160. Then you look upon the eastern entrance as very objectionable, on the score of deposit taking place in the harbour, do you?—No.

1161. Your answer conveyed that to my mind, at any rate?—Perhaps I did not quite understand the question.

1162. What I said was this: I gather from what you have just told us, that you hold the maintenance of this existing eastern entrance to be most objectionable on the ground of its giving rise to deposit within the harbour?—No, I did not state that.

1163. I so understood it?—The eastern entrance, you say?

1164. Yes?—Oh, no; I mean the disturbance it creates, and the action that takes place all along the shore at the base of the harbour in consequence of that disturbance.

1165. I am glad it is cleared up, because your answer left upon my mind the impression that the eastern entrance was objectionable?—I will illustrate it in the best way I can. No sewer from Madras can be kept open into the sea. It is simply an impossibility. The accumulation of sand everywhere is such at the debouchure that the moment an opening is made in one tide it is closed in the next by the action of the sand. No harbour, such as is suggested by Mr. Parkes, at the south-west angle of his present harbour, could be kept open for more than a tide at most in all rough weather, nor could the entrance of that boat harbour, which he suggested. I am only giving these as contingent advantages from the closing of the eastern mouth. There is yet a fourth reason, and it is this: the Madras harbour covers, I think, an area of 210 acres. Out of that space there is now not less than 40 acres lost entirely for mooring ships.

1166. Lost how?—Lost inwards from the three-fathom line to the shore; that is all at present useless for the mooring of the ships.

1167. Why lost?—On account of the surf, it is entirely lost.

1168. The surf breaks so heavily on the inner portion of the harbour that those acres are nearly lost for all useful purposes, you mean?—Yes, there are now 40 acres lost, but the moment you close the eastern entrance you make a still harbour, and you can dredge the whole of *this* out for mooring purposes, and not only so, but you can establish the means of landing goods by jetties and all the needful appliances along the whole base of the harbour, a matter that cannot be attempted in its present state. I attach, moreover, great importance to the question of establishing communication with the Buckingham canal and also of a boat harbour as proposed by Mr. Parkes. That is a proposal of which I thoroughly approve, though I cannot say that it could be carried out and maintained without closing the eastern entrance.

1169. Those objects cannot be attained with an eastern entrance, but you think that both of them might be attained by the closing of the eastern entrance and opening one to the north-east?—Yes.

1170. You spoke just now of working a dredger. When you proposed to move the material from the site of the north-east entrance by the dredger, had you lost sight of the fact that although the northern spur might be completed, the harbour would then be just as much disturbed for the use of the dredger as it is at this moment. I do not quite see the difference. You yourself have given strong reasons why the dredger could not be employed there; but although the north-east arm of the spur is carried out, the harbour, for a certain time, would be just as disturbed as it is at the present moment, would it not?—Of course, it requires a great deal of engineering consideration, but these are protected angles behind the shield. The wave naturally expends itself here, and these are the stillest portions of the whole harbour, although a great deal of this kind of material has had to be picked up in the Ardglass harbour and elsewhere under the Board of Works in Ireland. It is a very tedious business, but it is to be done.

1171. (*Admiral Sir George Nares.*) Then in the monsoon a dredger would be fairly safe, and we must take the risk of a cyclone smashing her to pieces. I mean that is the only alternative before us if we change the entrance, and use a dredger, is it not?—The steam hoppers that we had before were invariably sent to a snug place up the coast, and I do not see why the dredger should not be kept throughout the stormy season in that way. There are several of the rivers that debouche, one in particular, near one of the backwaters north of Madras, a place where native craft take refuge before these cyclone times occur. We used to send the hopper barges to the Godavery; but there would not be the same necessity for a dredger to go so far. There is one place to which the dredger might be sent up, Ennore, seven miles to the north of Madras, where there is a bar open. She might be sent in there, or to another open bar further north, and made snug in a backwater.

1172. Then, in fact, in the cyclonic season you think we should suspend work and send the dredger away?—Yes, that would be one method of dealing with it; another would be simply to lay her or ways to run her up the beach—it is a question of ingenuity, nothing more.

1173. How long would you call the cyclonic season, two or three months?—Well it is difficult to say without meteorological tables to refer to, but I have been accustomed myself to look upon the cyclone season as extending from about the 15th March to 1st June, and again from 15th October. On the 14th October the surf flag is generally hoisted; the cyclone season then extends from that date to about the 20th December.

1174. (*Sir John Coode.*) That is practically five months?—Yes.

1175. Two periods of 2½ months each?—Yes, about that.

1176. (*Admiral Sir George Nares.*) Then the opening of the north-east entrance practically comes to this, that in the present state of the works they must be completed under the original scheme before the north-east entrance is open?—Yes, with the exception of the angles. I do not think there need be so much work done at the elbows. I think some arrangement might be made by which expense could be saved at the elbows.

1177. By not putting in so many wave breaker blocks?—Or carrying it on piles; there are several methods. I would rather not say exactly how it should be done.

1178. (*Sir John Coode.*) Have you thought of the time that might be necessary to remove a sufficient quantity of the work to establish the north-east entrance?—No, I have not thought of that. I never would think of time or money in a matter of this kind.

1179. Neither time nor money you consider should be an objection to opening a north-east entrance; you consider that it should be done at any cost?—A cost of two or three millions sterling. It is, of course, difficult to specify any particular sum.

1180. It should not be governed by the cost or the time occupied, you think?—I do think so. The Secretary of State himself has laid down very nearly that principle in saying that "the question is too large to be dealt with only upon financial grounds."

Major-General Shaw Stewart examined.

1183. (*Chairman.*) Will you be so good as to give us the nature of your appointment during the time you had any opportunity of forming an opinion as to the Madras works?—I succeeded General Sankey as Secretary to Government and Chief Engineer of the Madras Public Works Department.

1184. When was that?—In 1883. That was an appointment that I held for three years.

1185. Subsequent to the destruction of the harbour?—Subsequent to the destruction of the harbour. Before that I had been holding an appointment in Madras, and took very great interest in the harbour, although not officially connected with it.

1186. But you had opportunities of watching it while it was in construction, and also during the short time that it was complete?—Frequent opportunities.

1187. Did you often go afloat yourself in the harbour?—Yes, pretty often; I should say "often."

1188. Should you say that under ordinary circumstances there was any great advantage to ships loading and unloading inside the harbour beyond what they would have in loading and unloading outside in the roadstead?—Do you mean in the harbour as it is now or as it was?

1189. We will begin with saying "as it was," when it was complete?—Yes, I should say distinctly there were advantages in ordinary weather.

1190. And now in its present ruined state what do you say?—Yes, I should say there are advantages still; not to the same extent, but certainly there are advantages, I should say.

1191. It is rather difficult to form an opinion without going one's self; but, ordinarily speaking, in fine weather was the harbour smooth or always more or less affected by the swell which appears to have been more or less constant from the eastward?—I should say that it was always more or less affected by the swell.

1192. That is to say, if you were alongside a ship and wanted to get from your boat on to the ladder, would you, under ordinary circumstances, have to watch your opportunity in ordinary weather?—No, I do not think I should have to do so.

1193. Are you in a position to give an opinion as to the best situation for an entrance to the harbour?—Independently of nautical considerations?

1194. I mean to say, what is your own opinion, from your own observations, independently of anybody else's observations? Judging from your own observation, whether you were then in a responsible position or not, have you formed such an opinion?—I have distinctly formed such an opinion.

1195. Will you give us that opinion?—I may mention that the existing entrance is not in the most suitable position with reference to the interior of the harbour. With reference to the facility of loading and unloading of cargo, and of passengers embarking and disembarking, I should say distinctly that it is not in the most suitable position.

1196. Have you ever been in Madras during a cyclone?—I have, during several.

1197. Have you watched the effects upon the harbour works and upon the harbour?—I have. I was in Madras during the cyclone of November 1881, and watched that very closely.

1181. (*Admiral Sir George Nares.*) You referred to the relative size and depth, or the depth and length of Kingstown and of Madras. With the information before us we have it that Kingstown is a broader harbour but shallower for a portion of its length from the entrance to the beach. I think you mentioned it as being deeper?—The length of Kingstown harbour must be taken from the seaward end of the west pier up to the root of the west pier at old Dunleary harbour, which measures 4,950 feet.

1182. You were speaking of the whole length, were you not?—Yes, the Board of Works have the question before them as to the disturbance created in what is called the old Dunleary harbour, and the traders' wharf. The seas entering, though not more ever than 2 feet to 2½ feet high, create such a disturbance that something will have eventually to be done to cut them off.

1198. The sea at that time, I believe, not only came in great masses over the breakwater, but the breakwater would appear to have offered very little opposition to it. It has been put as high as 20 feet above the breakwater?—It is very difficult to state exactly to what height the seas rose. The sea certainly broke over the breakwater, and after a very short time considerably damaged it; but it is extremely difficult to say to what height it broke over it.

1199. There are two sorts of seas that we have to deal with. One is the "run," that is said to come through the eastern entrance, and the other is the surface sea, which on an exceptional occasion like that of the cyclone of 1881, breaks over the harbour works. To which would you ascribe the greatest danger as affecting the small craft that have no means of safety by running away, but which must stop in the harbour?—I should say distinctly, to the sea that comes in through the opening.

1200. To the "run"?—Distinctly. I may mention perhaps in support of that, that on that occasion, in November 1881, almost all the damage in the harbour was done before the outer wall (the sea face), suffered. I was on the spot, and watched it very closely.

1201. Do you think that under the present plans for the reconstruction of the harbour, that is as regards the sectional plans, but with the eastern entrance closed, *that* harbour would be safe for ships to remain in during a cyclone?—I must premise that I have no nautical experience, but I should think it might.

1202. Suppose that the sea piled up to the height of something like 24 feet. [I think it was put at that height, because it actually struck the platform of the crane, I believe] there would, although the wall was raised to 12 feet, be a considerable amount of water still coming over, that water would have to find its way out again somehow or other, would it not?—Clearly, it must.

1203. Therefore, it would produce to a very great extent (no matter where you put the entrance,) the effect that was produced by the other entrance, making what is called a "boiling pot" of it?—Of course, to a certain extent, the water will come over the wall if it is raised 12 feet; that water, as you say, must find its way out; but if the eastern entrance were closed, and it were considered possible to substitute an entrance in another position, I do not think that the effect would ever be such as it was in November 1881.

1204. Have you ever taken into consideration an entrance at the south-east angle?—I have, both at the south-east angle and the north-east angle. I have thought of them both.

1205. To which would you give the preference?—I am extremely doubtful on that point. If it were possible to have an entrance at each angle I should think it would improve the possibility of getting into and out of the harbour at all times of the year very much. I see no objection to it, from an engineering point of view.

1206. Do you see any objection to it from the point of view of the movement of the sand?—None whatever. The movement of the sand has almost stopped, I think, at present. It is going on slowly, but I have reason to believe, from observations I have taken, that the movement is decreasing very much, and will, I think, ultimately stop.

1207. May I ask if you hold an appointment there now?—No; I hold no appointment.

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1208. Are you aware that there has lately appeared a round sand patch at the south-east corner?—I was not aware of that. It is since I left India that that has appeared.

1209. Supposing that there was this irregular action of the sand, and that a sand bank may crop up perhaps at your most critical point, and supposing that you could by closing up the eastern entrance afford shelter to a dredger, and keep a dredger there in safety; should you like to trust to a dredger to keep that entrance clear. I mean supposing you were to be responsible for the plans on which the works were constructed?—May I ask whether that is on the supposition that this is to be the only entrance or that there are to be two, one at each angle?

1210. Well, I was speaking then on the supposition that that was the only entrance?—No; I should not like to have this for the only entrance if the fact is, as has been stated by you, that a sand bank has appeared lately.

1211. You would not like to trust to a dredger for keeping your entrance clear?—No, not solely; certainly not.

1212. Supposing you had the two entrances, the north-east and the south-east, should you have any fear of the harbour silting up?—No, I think not.

1213. Supposing that the current which it is anticipated would pass through the two entrances (north and south, according to the monsoons) were they open and carried a quantity of sand with it, is it within your experience that a certain part of that sand would remain behind in the harbour?—I suppose a certain amount would, unquestionably; but I think the quantity would be one that could be easily dealt with by dredging.

1214. That is what I was coming to. Would you prefer the two entrances or the one entrance to the north-east?—I should prefer the two entrances.

1215. In view of the irregular movement of the sand?—Yes, certainly, in view of that.

1216. Supposing that you were confined to one entrance, and that to be a north-east entrance, have you considered the subject from a nautical point of view as well as from an engineering point of view, as to the facility of ingress and egress?—I have not, for I confess I have very little nautical knowledge.

1217. You have not taken the opinions of nautical men?—Yes; I have spoken to nautical men on the subject, but I have no knowledge of my own upon it.

1218. Have you realised that in opening that entrance you would give up, not only for the width of the entrance but for the additional width necessary to make a safe channel for ships entering and going out there, a great deal of your best anchoring ground during the north-east monsoon?—Yes, certainly, you would. I think by closing the eastern entrance you would also gain ground on that side.

1219. Do you think you would gain as much as you would lose?—I think so, or nearly. Of course, the north-east angle is the most sheltered in the north-east monsoon, at present.

1220. *This* plan represents nearly about the present state of the works. *This* is about where the north-east entrance would be; the work is completed as far as *that* spot there which you may say is two thirds across the proposed entrance to the north-east; the rubble bank is increased in width very considerably, and the new work is already completed so far. Have you considered at all what the time and cost would be of removing *that*?—I cannot say that I have.

1221. Would you remove it regardless of cost?—No, certainly not regardless of cost.

1222. Of course, you understand that every bit of it would have to be done by a diver?—Yes, it would.

1223. At present we know we cannot shelter a dredger, and that every bit of that work would have to be done by a diver; it must therefore take a very considerable time, because there is a great portion of the year in which a diver cannot work, and of course, if done at all, it would have to be done at a very considerable cost. Would you consider that the advantages arising from closing the eastern entrance and opening one to the north-east would compensate for the great cost of making the alteration?—There are two considerations or conditions I should like to attach to my answer on that. One is that I should desire to have some idea of the estimated cost of the operation, and the other is to have some idea of whether the north-east entrance would be considered by nautical men feasible. I think my answer would depend upon those two considerations.

1224. You have not made up your mind on that point as to whether you would recommend it?—All the answers I have received from nautical men, and I asked every one I came across at Madras, tended in one direction; but, of course, those were irresponsible answers or opinions given to me. I have no opinion of my own upon that point whatever; I cannot have. I suppose that the probable cost of removing the masonry to form a new north-east entrance would form something under 20 per cent. of the cost of the harbour.

1225. Eleven lacs of rupees, I think, is what Mr. Parkes mentions as a guess only. I think he distinctly says it is only a guess?—That is about 10 per cent. of the cost of the harbour. I should say the money would be very well spent if the north-east entrance was pronounced by nautical authorities to be feasible.

1226. (*Sir John Coode.*) Have you formed any idea of the number of days in the course of the year on which divers could work at operations on *this* elbow. Could you give us any idea of that from your own personal knowledge of the harbour? We have not seen it, but you have resided there so long that one would like you to give us the benefit of your opinion, if you have formed an opinion upon the point?—I have very full information upon the subject, but have not access to that information at present. My impression is that for about two-thirds of the year on the average divers could work there. That would be about 20 days out of every month on the average.

1227. It would not be 20 days a month during the whole year, would it?—Stoppages would occur at the changes of the monsoon; would they not?—On the average it would be, I think, about two-thirds of the year.

1228. When you spoke just now of the advantages that this harbour gave, in the embarking and disembarking of passengers and the landing and discharging of goods, you were not at all touching upon the point that was subsequently put to you with regard to the facility of ingress and egress of large vessels through the north-east entrance as compared with the eastern entrance. Have you formed any opinion upon that point. Do you think that large steamers could get in and out as readily through the north-east entrance as they could through the eastern entrance?—I suppose not.

1229. It is simply as regards the quiescence of the sea that the north-east entrance would afford, as compared with the eastern entrance, I gather?—Clearly.

1230. I understand that you were at Madras on the 12th November 1881 when the cyclone occurred?—I was at the harbour most of the time.

1231. About what period of the day did the breach first reveal itself?—I think it was about 1 p.m., so far as I can remember.

1232. At any rate, about noon?—About noon.

1233. And I think it was stated on the Hawkshaw committee, that it was about 11 o'clock. At any rate the point I want to come at is this: There were several hours of daylight before it commenced, were there not?—Yes.

1234. Had you noticed before the breach took place what was the condition of the sea on the foreshore. Before the breach happened, was the water much disturbed along the beach?—Very much.

1235. Had much of the beach been clawed away by the sea?—A great deal, and a great deal of damage done.

1236. Damage done to property, or only in the removal of the line of foreshore?—Damage to property, damage to boats, damage to ships, damage to jetties, damage to almost everything. I particularly noticed that. I observed that most of the damage was done before the sea face gave way.

1237. General Sankey has told us also, that before the walls gave way the removal of sand on the foreshore had taken place to a certain extent; that there was practically a vertical face of several feet exposed to the action of the sea along the line of foreshore?—I did not notice that.

1238. What was the character of the sea before the wall gave way through the harbour generally. Was there any portion of it which was quiet, or was it all

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disturbed?—It seemed to me to be one mass of disturbed water, but I think, so far as I remember, there was some quietness *here*.

1239. When you say "here" you mean just under the knuckle of the northern arm?—Under the knuckle of the northern arm; under the north-east angle.

1240. Was the sea regular or irregular?—Very irregular.

1241. Did anything come within your knowledge as to the boatmen being asked to put off to endeavour to release the men who were on the hopper-barges?—No, nothing came within my knowledge. I heard of it afterwards. I did not hear of it at the time.

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1243. Was the character of the sea along the beach between the two piers very different from that along the beach north and south of the harbour?—The action of the sea was very much more irregular. *Here* was the regular surf, and *there* the effect of the sea was very striking.

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1248. Yes?—It was washing right over it. I tried to get to the end of it, and did not succeed. I could not, I think, but I did not, certainly.

1249. Is it within your knowledge whether any portion of the deck of that jetty was or was not washed up during the cyclone?—No; I am not able to state whether it was or not.

1250. Have you watched the accumulation of sand on the south very narrowly and closely over a long period, so as to be able to give us an idea of what is going on there?—I have watched it very closely, I may say. I have not taken sections of it, or anything of that kind. That has been done, I know, at the harbour works constantly and regularly. The accretion at first was very rapid. Latterly it has been much less so, and I was in hopes, from the observations I have made, that it showed a disposition to cease. I am very much concerned to hear of this sand bank having formed there.

1251. (*Admiral Sir George Nares.*) Are you aware that in about six fathoms of water at the south side of the harbour there has been a shoaling of about three feet, as shown by the latest soundings?—Since when?

1252. Since the harbour was commenced; that is to say, that there has not only been the accretion of the beach seaward up to high-water line, but that the last survey, in addition to showing a shoal forming at the knuckle at the end of the south pier, shows that the actual whole of the bottom of the sea out to six fathoms has silted up considerably?—I know it had silted up. I did not know it had silted up so much as you say, three feet.

1253. As you were on the screw pile pier at the time of the cyclone, can you tell us where the damage was most serious, or on what part of the pier; was it the outer end of the pier or the inner end of the pier?—It must have been at the outer end of the pier, because I was on the inner part of the pier myself.

1254. And all that remained intact?—So far as my knowledge went, it did. While I was there it certainly was intact.

1255. The sea broke inside the end of the pier, did it not, or was the first breaker outside the pier?—The whole interior of the harbour was a mass of confused water. It is very difficult to say where the breakers broke in there. It was quite different to the ordinary line of breakers on the N. E. beach. It would be exceedingly difficult to say where the seas broke.

1256. You told us that the water in the ordinary monsoon weather inside the harbour was fairly quieted?—Yes, in the ordinary weather. Did I say "ordinary monsoons"?

1257. In the ordinary monsoon season, I think you said?—Ordinary weather I meant to say.

1258. The north-east monsoon, I believe, is the worst; would it be fairly quieted behind the northern arm, in the worst monsoon weather? Would there be fairly quiet water for one or two ships?—"In the worst monsoon weather" I understand to be your question?

1259. Yes, the worst monsoon weather; not a cyclone?—I think so, certainly.

1260. Then, with heightened walls, a wave breaker and a narrowed entrance, in ordinary monsoon weather, the harbour will afford considerably better shelter than it did before?—Certainly.

1261. And more protection in a cyclone; that is to say, that the damage on the beach in a cyclone would not be quite so bad?—No, certainly not; it must, *pro tanto*, be less, of course.

1262. Then, wherever the entrance is in the harbour, it would be fairly quiet in ordinary monsoon weather?—Yes; a certain portion of the harbour would be quiet in the north-east monsoon weather.

1263. The question of the position of the entrance then is mainly of importance with regard to cyclonic weather?—No, I think not. I think it is important with regard to all weather, but mainly important in cyclone weather.

1264. Do you think with a north-east entrance and heightened walls and an improved formation of the breakwater, that sailing ships could remain in there in a cyclone with safety?—That is a question I am scarcely able to answer. To the best of my knowledge I have never seen a sailing vessel (except very small ones) in the harbour.

1265. We have been told that they are not allowed in there; but I want to know whether you think they would be able to use the harbour?—I am rather afraid to give an opinion upon that point.

1266. I want to know in fact, whether in your opinion the harbour could ever be made into a refuge harbour?—For steam vessels I think it could, not for sailing vessels.

1267. Not for everybody?—No, I should doubt its being made available as a harbour of refuge for every kind of vessel. It would be exceedingly difficult for a sailing vessel to come in at the north-east entrance. It strikes me as a landsman that that is so.

1268. From what you know of the nautical opinion, do you think that steamers will still put to sea if they know that a cyclone is coming on, and that they will not remain in the harbour?—I think they would under any circumstances go to sea.

1269. Wherever the entrance might be?—Yes, I think they would.

1270. Taking the present state of the works, they must be practically completed on the original scheme, must they not, with the eastern entrance, before we can open a north-east one?—Yes, I think they must be, especially as the work has progressed so far. I am not sure that it would not be possible if the work has been stopped at *this* point to dispense with some of it.

1271. It is stopped now?—I do not think it would be necessary to go on to close up the remainder of *that* gap with solid blocks. I think it might be done in a temporary manner.

1272. The short distance might still be left open you think?—I think so. It is a question.

1273. That would be the only difference?—That would be the only difference, I think.

1274. Do you know how far south of the harbour the beach accretion has shown itself? About how many miles?—I know the exact point, but it is very difficult to state the exact distance.

1275. Is it about a mile?—More than a mile certainly. I should say about a mile and a half.

1276. (*Sir John Coode.*) When you spoke of the portion of the opening yet to be covered being dealt with

1208. Are you aware that there has lately appeared a round sand patch at the south-east corner?—I was not aware of that. It is since I left India that that has appeared.

1209. Supposing that there was this irregular action of the sand, and that a sand bank may crop up perhaps at your most critical point, and supposing that you could by closing up the eastern entrance afford shelter to a dredger, and keep a dredger there in safety; should you like to trust to a dredger to keep that entrance clear. I mean supposing you were to be responsible for the plans on which the works were constructed?—May I ask whether that is on the supposition that this is to be the only entrance or that there are to be two, one at each angle?

1210. Well, I was speaking then on the supposition that that was the only entrance?—No; I should not like to have this for the only entrance if the fact is, as has been stated by you, that a sand bank has appeared lately.

1211. You would not like to trust to a dredger for keeping your entrance clear?—No, not solely; certainly not.

1212. Supposing you had the two entrances, the north-east and the south-east, should you have any fear of the harbour silting up?—No, I think not.

1213. Supposing that the current which it is anticipated would pass through the two entrances (north and south, according to the monsoons) were they open and carried a quantity of sand with it, is it within your experience that a certain part of that sand would remain behind in the harbour?—I suppose a certain amount would, unquestionably; but I think the quantity would be one that could be easily dealt with by dredging.

1214. That is what I was coming to. Would you prefer the two entrances or the one entrance to the north-east?—I should prefer the two entrances.

1215. In view of the irregular movement of the sand?—Yes, certainly, in view of that.

1216. Supposing that you were confined to one entrance, and that to be a north-east entrance, have you considered the subject from a nautical point of view as well as from an engineering point of view, as to the facility of ingress and egress?—I have not, for I confess I have very little nautical knowledge.

1217. You have not taken the opinions of nautical men?—Yes; I have spoken to nautical men on the subject, but I have no knowledge of my own upon it.

1218. Have you realised that in opening that entrance you would give up, not only for the width of the entrance but for the additional width necessary to make a safe channel for ships entering and going out there, a great deal of your best anchoring ground during the north-east monsoon?—Yes, certainly, you would. I think by closing the eastern entrance you would also gain ground on that side.

1219. Do you think you would gain as much as you would lose?—I think so, or nearly. Of course, the north-east angle is the most sheltered in the north-east monsoon, at present.

1220. *This* plan represents nearly about the present state of the works. *This* is about where the north-east entrance would be; the work is completed as far as *that* spot there which you may say is two thirds across the proposed entrance to the north-east; the rubble bank is increased in width very considerably, and the new work is already completed so far. Have you considered at all what the time and cost would be of removing *that*?—I cannot say that I have.

1221. Would you remove it regardless of cost?—No, certainly not regardless of cost.

1222. Of course, you understand that every bit of it would have to be done by a diver?—Yes, it would.

1223. At present we know we cannot shelter a dredger, and that every bit of that work would have to be done by a diver; it must therefore take a very considerable time, because there is a great portion of the year in which a diver cannot work, and of course, if done at all, it would have to be done at a very considerable cost. Would you consider that the advantages arising from closing the eastern entrance and opening one to the north-east would compensate for the great cost of making the alteration?—There are two considerations or conditions I should like to attach to my answer on that. One is that I should desire to have some idea of the estimated cost of the operation, and the other is to have some idea of whether the north-east entrance would be considered by nautical men feasible. I think my answer would depend upon those two considerations.

1224. You have not made up your mind on that point as to whether you would recommend it?—All the answers I have received from nautical men, and I asked every one I came across at Madras, tended in one direction; but, of course, those were irresponsible answers or opinions given to me. I have no opinion of my own upon that point whatever; I cannot have. I suppose that the probable cost of removing the masonry to form a new north-east entrance would form something under 20 per cent. of the cost of the harbour.

1225. Eleven lacs of rupees, I think, is what Mr. Parkes mentions as a guess only. I think he distinctly says it is only a guess?—That is about 10 per cent. of the cost of the harbour. I should say the money would be very well spent if the north-east entrance was pronounced by nautical authorities to be feasible.

1226. (*Sir John Coode.*) Have you formed any idea of the number of days in the course of the year on which divers could work at operations on this elbow. Could you give us any idea of that from your own personal knowledge of the harbour? We have not seen it, but you have resided there so long that one would like you to give us the benefit of your opinion, if you have formed an opinion upon the point?—I have very full information upon the subject, but have not access to that information at present. My impression is that for about two-thirds of the year on the average divers could work there. That would be about 20 days out of every month on the average.

1227. It would not be 20 days a month during the whole year, would it?—Stoppages would occur at the changes of the monsoon; would they not?—On the average it would be, I think, about two-thirds of the year.

1228. When you spoke just now of the advantages that this harbour gave, in the embarking and disembarking of passengers and the landing and discharging of goods, you were not at all touching upon the point that was subsequently put to you with regard to the facility of ingress and egress of large vessels through the north-east entrance as compared with the eastern entrance. Have you formed any opinion upon that point. Do you think that large steamers could get in and out as readily through the north-east entrance as they could through the eastern entrance?—I suppose not.

1229. It is simply as regards the quiescence of the sea that the north-east entrance would afford, as compared with the eastern entrance, I gather?—Clearly.

1230. I understand that you were at Madras on the 12th November 1881 when the cyclone occurred?—I was at the harbour most of the time.

1231. About what period of the day did the breach first reveal itself?—I think it was about 1 p.m., so far as I can remember.

1232. At any rate, about noon?—About noon.

1233. And I think it was stated on the Hawkshaw committee, that it was about 11 o'clock. At any rate the point I want to come at is this: There were several hours of daylight before it commenced, were there not?—Yes.

1234. Had you noticed before the breach took place what was the condition of the sea on the foreshore. Before the breach happened, was the water much disturbed along the beach?—Very much.

1235. Had much of the beach been clawed away by the sea?—A great deal, and a great deal of damage done.

1236. Damage done to property, or only in the removal of the line of foreshore?—Damage to property, damage to boats, damage to ships, damage to jetties, damage to almost everything. I particularly noticed that. I observed that most of the damage was done before the sea face gave way.

1237. General Sankey has told us also, that before the walls gave way the removal of sand on the foreshore had taken place to a certain extent; that there was practically a vertical face of several feet exposed to the action of the sea along the line of foreshore?—I did not notice that.

1238. What was the character of the sea before the wall gave way through the harbour generally. Was there any portion of it which was quiet, or was it all

disturbed?—It seemed to me to be one mass of disturbed water, but I think, so far as I remember, there was some quietness *here*.

1239. When you say "here" you mean just under the knuckle of the northern arm?—Under the knuckle of the northern arm; under the north-east angle.

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1275. Is it about a mile?—More than a mile certainly. I should say about a mile and a half.

1276. (*Sir John Coode.*) When you spoke of the portion of the opening yet to be covered being dealt with

Major-Gen. S. Stewart. 13 May 1887.

in a temporary manner, did you consider that that must be sufficiently strong to resist a cyclone or a gale of wind that might occur in the meantime?—It is a question that has never occurred to me. I gave that answer rather without consideration.

1277. I think it is only fair to you to ask that question, because you see any work of that kind, although serving a temporary object, must be sufficiently strong to resist whatever may happen in the meantime?—There is no doubt of that whatever.

1278. Therefore, it would not mean "temporary" in the sense of involving a small expense?—Certainly not. In fact it would be an open question as to whether it would not be necessary to complete the work in its entirety.

1279. (*Admiral Sir George Nares.*) And whether completing the work would not be the cheapest way of doing it?—Yes.

1280. Only perhaps leaving out the wave breakers?—Yes.

1281. (*Sir John Coode.*) Wholly or partially completing it?—Yes.

1282. It is a question whether it would be safe to leave it without some portion of wave breaker, is it not?—Yes.

1283. (*Chairman.*) Were you at Madras during the cyclone of 1872?—I was; the 2nd May 1872, I think it was.

1284. Therefore, you have had an opportunity of comparing the force of the wind and sea on the two occasions, 1872 and 1881?—I have.

1285. Which was the worst as regards the severity of the wind and sea?—I think the force of the wind was considerably stronger in 1872 than it was in 1881, and with regard to the sea also, I should say that the sea was higher and heavier in 1872 than it was in 1881.

1286. As I understand, the sea inside the harbour in 1881 was of a totally different character to the sea that would have broken upon the beach in 1872?—Very different.

1287. Were you able to compare the two?—In 1872 it was simply impossible to go near the iron screw pile pier.

1288. The iron screw pile pier then existed, did it?—It then existed. It was broken, I think, by a vessel. As far as I can remember, a small sailing vessel drifted on to it and broke through it.

1289. In 1881 did you observe the surf breaking on the beach at any distance from the harbour works?—I did; I drove for two miles along the beach before I got to the harbour works.

1290. And it is from the comparison between those breakers and the breakers of 1872 that you think those of 1872 were the worse?—Yes, certainly. I have no hesitation whatever in saying so.

1291. You may say that speaking broadly, that in 1881 the harbour works did not see the worst weather to which they might possibly be exposed?—No, even within my limited experience they did not.

1292. (*Sir John Coode.*) Then you are quite clear that the sea in the roadstead and on the coast generally was distinctly heavier in the cyclone of 1872 than it was in the cyclone of 1881?—Certainly; so far as my observation goes it was distinctly.

1293. If the works that were destroyed had been there in 1872 they would have had a heavier sea to resist than they had in 1881?—There is no doubt whatever about it. I have no doubt on the point whatever.

1294. We are speaking of the sea now. Putting aside the question of the wind, is that still your opinion?—Yes, I have no hesitation in saying so.

Adjourned *sine die*.

At the Board of Trade, Whitehall.

Wednesday, 8th June 1887.

MEMBERS PRESENT:

VICE-ADMIRAL SIR NOWELL SALMON, V.C., K.C.B., IN THE CHAIR.

SIR JOHN COODE, K.C.M.G.

REAR-ADMIRAL SIR GEORGE S. NARES, K.C.B.

MR. F. C. THOMPSON (India Office), *Secretary*.

Captain J. H. TAYLOR examined.

Capt. J. H. Taylor. 8 June 1887.

1295. (*Chairman.*) Will you please tell the Committee what is your position?—I am port officer at Madras.

1296. From whom do you hold your appointment?—The Government of India.

1297. What is your position with regard to the Port Trust?—I am a member of it; what may be called an official member.

1298. And what is the position of the Port Trust with regard to the harbour?—The Port Trust have the whole charge of the harbour. It may be considered their property as made over to them by the Act of the Governor-General.

1299. The harbour was not originally constructed by the Port Trust, I believe?—Oh, no; the Port Trust has only been one year in existence.

1300. So that the harbour has been handed over to the Port Trust since its destruction in 1881?—Yes, from the 1st June 1886.

1301. Does the subject of the reconstruction of the harbour rest with the Port Trust or with the Indian Government?—The Port Trust consider that it rests with them.

1302. And the Port Trust consider then that it is for them to decide as to upon what plan it shall be reconstructed?—Subject, of course, to engineering and other authority.

1303. Quite so; but not subject to the Indian Government?—They did not consider it so until a telegram came from the Secretary of State to say that they must not interfere with the construction.

1304. May we understand then that the Indian Government can so far interfere with the plans for the reconstruction of Madras harbour, that it can refuse to lend the money if it does not approve of the plan?—That would be a legal question. They have bound themselves by the Act which I have here to advance the money, and I am not quite clear upon that point. If one portion of the Act is binding, why the rest must be.

1305. That is under the Madras Act, No. 2 of 1886 which you now hand in?—Yes (*the same was handed in*).

1306. It would appear by this Act that, subject to the payment of 4½ per cent. interest on 46 lacs of rupees, and the repayment of the principal of that sum at the rate of one lac a year, the harbour works as they stand now are vested in the harbour trust; that is the case, is it not?—That is the case. That is the ultimate result; but at present we only pay on each year. Suppose six lacs were spent this year we only pay the interest on the six lacs, but we pay the whole capital sum just the same.

1307. Has the Port Trust the means of continuing the reconstruction of the harbour?—They have their engineer now, Mr. Thorowgood.

1308. By "the means" I mean the money?—Oh, yes.

1309. From what source is that derived?—From the tax on the landing and shipping of goods, which is justified by the Act.

1310. Then they are in a position to reconstruct the harbour without borrowing further money?—No, not without borrowing. That would, of course, involve a great deal more. They would not borrow from any body but the Secretary of State. There is no intention whatever of that, and there is no necessity for that.

1311. Supposing that the Secretary of State were to decline to lend money to make an alteration in the plan of the harbour, in your opinion would it be in the power of the Madras Trust to borrow money elsewhere for the purpose?—I do not think that is a question I can answer. It would be a legal question.

1312. That would rather test the proprietorship?—At present there is no supposition on either side that there would be any falling off.

1313. (*Admiral Sir G. Nares.*) Has the whole of the 46 lacs been advanced already?—No, it is advanced as wanted.

1314. It is an advance up to 46 lacs?—Yes; that is Mr. Parkes' calculation of the restoration of the harbour; and annually, whatever sum is disbursed we pay interest upon, but we always pay the one lac to the capital account. It is a sinking fund, in fact.

1315. And that money is promised to be advanced on Mr. Parkes' plans, is it?—That I am not prepared to say. Mr. Parkes has had a good many plans.

1316. (*Sir John Coode.*) Then you are not paying principal and interest now on the sum expended up to the time the Trust came into operation, are you?—Yes, we are.

1317. You are paying interest on that as well, are you?—On the sum expended.

1318. From the commencement?—No, since 1883. Before 1883 I had charge of the whole thing, and used to draw the money, and it went into the General Port Fund Account.

1319. Then what is the amount expended since 1883 up to the present time. It is important to know that?—I cannot tell you that. The Port Trust has only quite recently been put in possession of the full amount. We have hitherto gone on the Accountant-General's estimate. He just furnishes an estimate, but now the Government have made over the whole of the account and everything else to the Port Trust, but I am not prepared to say what the figures are.

1320. (*Chairman.*) How long have you been connected with Madras harbour?—Since the first stone was laid.

1321. That was in 1879, I think?—1875; the Prince of Wales laid the first stone.

1322. Have you been in the habit of taking ships in and out yourself?—Oh, no, my duty is far superior to that.

1323. At no time?—No.

1324. Have you ever done such a thing?—I commanded a ship 25 years. I had the command of both sailing and steam ships.

1325. Have you ever taken a large modern steamer in or out of Madras harbour?—Oh, no. I have seen them all come in and go out from my office window. There is no difficulty whatever found in getting in or out.

1326. Do you think that reducing the eastern entrance by 100 feet would increase the difficulty, to any sensible degree?—Yes, I am quite certain of that, because a ship would then be compelled to go straight out, which is not always possible when there is a row of ships behind her. The head pilot has come here to give evidence, and he can give that information better than I can. At present he is often obliged to take a ship out angling, which he would never be able to do with a 400 or 450 feet entrance.

1327. (*Sir John Coode.*) Would he be obliged to take her out angling at the entrance?—Yes.

1328. I can quite understand that he might do so in taking up her position?—True, but she must have good way upon her, and she would not have room to turn.

1329. May not that happen, more or less, with the entrance in any direction?—Yes, more or less, if it were narrow, except with the north entrance, which is proposed now; that would be a straight push out into the sea.

1330. That would depend upon the way the vessel was lying?—There is no difficulty.

1331. (*Chairman.*) Do you think if the eastern entrance were closed and an entrance formed at the north-east corner that it would be equally easy to take ships in and out?—Easier, a great deal.

1332. (*Admiral Sir George Nares.*) With what breadth of opening?—You may have 600 or 700 feet there, if you like; and you would also have more water and a larger harbour.

1333. Do you mean deeper water?—Yes. At present we cannot utilise the deep-water space, it is all taken up by allowing ships to come up right and left to their berths; but by carrying the opening to the north-east we could utilise the whole of the deep-water space, which now is idle.

1334. Utilise it for what?—For ships.

1335. For mooring, or for passing in and out?—For mooring, for discharging.

1336. (*Chairman.*) In opening that entrance, as you say, 600 or 700 feet, you are aware that you open it inshore. You cannot open it further seaward; and therefore, the further you come the nearer the ship has to come in towards the breakers?—We propose to open it straight along. Will you allow me to put in the Port Trust papers, or shall I read them?

1337. I think we will finish your evidence first, because we are specially appointed to get nautical opinions on the question of entering the harbour. I will ask you the question that has been put to each nautical man that has given evidence here. I think the proposal, so far as it had gone before you came here, was 500 feet, which would come to about "B." Will you put yourself in the position of the captain of a large steamer, we will say, of 450 feet, or between that and 500 feet, the swell setting directly, or nearly directly, on the line of the beach, with not exceptional weather, but ordinary north-east monsoon weather, with squalls of wind, would you like to turn your ship in there under that protecting arm?—*This* is the old Madras harbour, the old Madras Committee scheme. It did not meet with favour from us.

1338. It is the only scheme before us as yet.—Yes, certainly, I should prefer coming in at the N.E. entrance. You suppose strong wind from the north?

1339. I suppose a strong north-east monsoon.—The entrance being, as I understand, 9 or 12 feet above the level of the sea.

1340. (*Admiral Sir George Nares.*) The breakwater?—Yes, 9 or 12 feet. It, in fact, shelters the whole of the ship, you may say. A ship comes in from the seaward between C and F. When she gets half-way in she must slow before she comes on, because she has got only a small space between her and the leading ships. Then the first half enters the eastern entrance, and is becalmed. The whole force of the wind and current then bears on her aft half, 225 feet long, and has a tendency to bear her over against "F."

1341. (*Chairman.*) Would not something similar take place in the case of a north-east entrance?—No; because the wind would be right aft. She would only have to slow down. She could slow when she liked.

1342. You think that the swell, being abeam instead of right aft, would not have the same effect, to a certain extent, as that which you attribute to the wind going in at the other entrance?—There would be no difficulty in the northern entrance, and no very great difficulty in *this* except as a comparison between the two—if I am asked for a comparison; but I see no difficulty myself, nor do our pilots see any difficulty. It would never have occurred to us to raise a difficulty about the entrance.

1343. (*Admiral Sir George Nares.*) There is no present difficulty in bringing a ship in at the eastern entrance except in regard to the number of vessels that are in the harbour?—That is so.

1344. There is no difficulty with regard to the sea?—There might be a difficulty if you attempted to come in in bad weather, but they do not do that.

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1345. But there will be more difficulty when the breakwater is finished, I understand, because the bow of the ship will be becalmed?—Yes.

1346. But in the case of these large ships, 400 or 500 feet long, what is the height of their bulwarks above water?—I suppose about 18 or 20 feet. There would still be a large portion of them visible.

1347. (*Chairman.*) If once the bow of the ship was inside the harbour, which do you think would be the best position for taking up a berth, the eastern entrance or the north-east entrance?—I cannot imagine any difference. It would depend upon where the berth was.

1348. Do you think it would be more difficult to stop the ship's way, coming into a small harbour like that, if you had the wind behind you than if you had the wind abeam?—No, you only have to go astern. You can stop her in the entrance if you like. If we had smooth water we could stop the ship when entered, as warp up to a place; but without smooth water we can do nothing.

1349. No matter what the wind might be?—No. There is always a little movement of the sea inside both on the beach and in the harbour, so that you cannot bring ships into anything like juxtaposition, they would grind themselves to pieces. You cannot carry out a warp to a ship because the movement is sufficient to break any line that we can use.

1350. (*Sir John Coode.*) Is that a common occurrence?—No; they break their own warps now. They make their own warps fast to stern buoys, and they are constantly parting themselves or pulling the buoys away.

1351. (*Chairman.*) That brings us to what we might have gone into before, the state of the sea inside the harbour. The principal reason why you wish to remove the entrance is on account of the disturbed water inside the harbour, owing to the opening in the eastern wall, is it not?—Yes; but irrespective of any question connected with the ships, it effectually stops any beach improvement, which is the only thing that can relieve the trade of the port.

1352. By which you mean jetties?—Jetties; a place where the boats can lie to discharge their cargo by hand, instead of lifting it up to a 20-feet pier.

1353. (*Sir John Coode.*) Owing to the disturbance?—Owing to the disturbance.

1354. Is that a matter that occurs several times during the week?—You can never land on the beach except with Masoolah boats, and they get knocked about. Lighters cannot go on the beach at all. There is always enough surf to break up any boat built of iron.

1355. Always?—Always, even in the finest weather.

1356. Do you think that would be removed by the construction of the north-east entrance and closing that on the east?—Certainly; we should have perfectly smooth water inside. You might run out low-level jetties on which the lighters might run, and have warehouses on the shore to which the goods could be conveyed at once. *Now* everything has to come on to the single road, and be passed on. Some perishable goods pass into the Custom House, and the rest are left until their owners come and carry them away. In fact, the trade of the place is blocked up for the want of low-level jetties.

1357. Do you find goods damaged in the operation of landing?—Yes, very often in hoisting them up and lowering them down from that height.

1358. (*Chairman.*) Still, the harbour as it existed before the typhoon carried it away, and even as it exists now, affords a certain amount of protection, does it not?—Well, I will tell you exactly a fact that occurred on that November day when the wall fell down. I had been up all night (as I always am under such circumstances) in my office, because there was a sailing ship up in the roads that might be in some danger. In the morning when I went down to the pier the lighters were all wrecked but two, and all the Masoolah boats not beached. Those who were not able to carry their boats high enough had them broken. We had commenced to run out two low-level jetties then about 300 feet each. They were made of strong rubble. Mr. Thorowgood built them. They were spread all over the place, damaging the boats; and at that time not a stone of the wall had parted from the sea face.

1359. Still, the sea was coming over, was it not?—Not there. It came over a little, but very little. It comes over principally at the side. It never comes into the beach, but rolls along the wall. The sea came over, but the waves did not reform on the inside at all.

1360. (*Admiral Sir George Nares.*) Inside?—Inside. I called on Mr. Grant Duff, the Governor, on my way down, and I said this storm is probably a very fair test of the harbour. It is a failure in one thing, inasmuch as all the boats are wrecked, and our low-level jetties destroyed, but hitherto I could find no fault in the wall. I left him, and in driving down to the beach I came by the lighthouse, and to my surprise, I saw the Titan crane gradually sink, sink, sink, sink, until I lost sight of it.

1361. (*Sir John Coode.*) That is the eastern face of the south arm?—It just slowly sunk. In a very few minutes afterwards the eastern face of the north arm followed. By the time I got to the office there were breaches in the wall in many places; and here and there there were parts standing up on both sides. In one part to the east of southward, there was an opening of 18 feet, which for a long time was used by boats going in and out to ships in the offing.

1362. (*Chairman.*) Still, ships made use of the harbour?—Of course they come in. They are protected from the currents between the walls. Consequently, they are enabled to lie in tiers, which they could not do in the open.

1363. I mean that they prefer paying the dues for using the harbour for loading and unloading, to loading and unloading in the roads outside, where they would have to pay nothing?—No; they would have to pay. At present, they have to pay whether they come in or not. Your question of course means, that they come in to do their work in preference to staying outside?

1364. Yes?—That is partly because the boats will not go out to them. When they found that they could get work so close to from ships coming in, they refused to go to ships outside. The consequence was that it was a question with the ships whether they would lose their time and money, or pay the small sum, viz., pilotage, required to come in. That was a matter of detail connected with the trade.

1365. And you think that that had nothing to do with the protection afforded at the piers?—Not at first, certainly.

1366. I understand the sailing ships still lie outside?—They must; we have no means of bringing them in.

1367. Will not the cargo boats go out to them?—They have great difficulty to get them to go, and have to pay a very large sum for them. Ships very rarely come with any cargo now. They only come to take emigrants. I do not think there has been for a long time any cargo except grain, which can be landed in Masoolah boats outside or inside. No sailing vessel with heavy weights has come in for several years, or with an ordinary London cargo.

1368. You are frequently afloat in the harbour are you not?—Of course.

1369. In all weathers?—In all weathers.

1370. Where do you embark and disembark?—At the pier.

1371. Ordinarily speaking, is there any difficulty in embarking and disembarking there. I mean, have you to watch your opportunity?—You very often have to watch your opportunity to jump in. With ladies it is often a very troublesome operation, but not more so than getting up the ship's ladder afterwards. That is just the same, if not worse, because the ships move and the ladder is a shaky one.

1372. You say that the beach is never safe for anything but Masoolah boats inside the harbour,—is that particular motion constant?—Almost constant, so much so that all passengers have almost the same dread they used to have in going off to the ships; and the boatmen very often tell you that it is worse inside than it is out.

1373. And that is caused by the sea coming through the eastern entrance and not by the effect of any wind, or any ground swell, coming through the eastern entrance?—The ground swell is the curse of the whole Coromandel coast. It is nothing to do with the wind swell; the wind may be off shore. You do not get any smoother water with the wind from the west-north-west, or the west. Many hours before the wall fell the wind

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was from west-north-west. The swells caused by a distant storm come right in, and they come in so rapidly, and so high, that they do not disperse sideways as Mr. Parkes expected they would. They come straight up to the beach; and on that particular occasion that I mentioned, about the wall falling down, many of the planks at the outer end of the pier 18 feet 6 inches above mean sea level were ripped up before a single block had fallen from the wall.

1374. That plan you have before you represents roughly the idea of a north-east entrance, supposing it to be decided to open an entrance at that corner and close up the eastern one, would that idea find favour with the harbour trust?—No, not now, because it has been rendered impossible in that doubling the wall just at that particular place. There is a gigantic mass of stone there now capable of holding a 100-ton gun, or a lighthouse, or anything else; and to lift that up would be impossible. We find it would be much easier to let it stop where it is now or just finish up that end, and carry the protecting arm out straight northwards, which would give not only a much wider opening, but a much easier one, and cost nothing but to remove the broken stones.

1375. Can you put in a plan showing the view that the Port Trust entertain?—*That* is the one which finds favour with the Port Trust.

1376. (*Sir John Coode.*) You said that the boatmen considered that it was worse now than before the harbour was constructed. What do you yourself think upon that point?—I think it is the same.

1377. No better and no worse?—No better and no worse. In the 1874 gale, before the harbour was commenced, or thought of, the same thing occurred *here* on the pier. The planks at the end of the pier were all ripped up. I commanded a ship then, and came in the very next day to the roads. The whole coast was lined with wrecks all round, and I found that the whole of the upper end of the pier, the iron plates of the turntable, and other things, had been washed up. That same thing occurred after the walls were up and the protection proposed by the original plan finished.

1378. You spoke just now of the great disturbance within the harbour before the sea faces gave way. Was there not at that time a considerable body of sea coming over, both on the north side and on the south side?—Very little on the south side.

1379. But was there not a considerable quantity on the north?—No, very little came in. The water rolled all along. A portion, of course, came in, and to such an extent that it overflowed the tide gauge at the end of the pier, it rose 2½ feet; a current was caused out through the mouth, so that many of the wrecks of the Masoolah boats and lighters were carried out through *this* opening into the sea by the force of the water, the water being full in the harbour, and that being the only opening left for it. The people in the ships in the roads said they saw lighters and things going out past them.

1380. Is not that a proof that there was a considerable quantity of water coming over the straight arm?—There was a quantity. There was no wave formed inside it.

1381. Not by the water which came over?—No, no wave whatever. From about *there* it was quite as smooth as it was in any other part. The peculiarity of these storms is that during certain periods of the storm at one time the swell will come in through the entrance and search the northward corner, at other times, as the storm veers, it will come in and attack the pier in the central portion; it will come in and attack the south-east or the south-west corner, so that there is hardly any portion of it in bad weather but is visited by the ground swell. It has nothing whatever to do with the wind. The wind will be off shore, or it may be anywhere. It is the ground swell connected with the storm.

1382. (*Chairman.*) Have you taken into consideration at all the question of an opening at the south-east angle?—Yes, that is, I consider, rendered impossible by the silt. The sand has now come up to the 5-fathom contour line, and that operates in obedience to a law of nature.

1383. (*Admiral Sir George Nares.*) Is that above water?—Yes, it is dry.

1384. It is dry at the old 5-fathom water-line?—About, I cannot tell you exactly.

1385. About there?—Yes. The action of the sand coming up from the south and forming against *this* wall has, to a certain extent, ceased. That is owing to the current coming round *here* in the north-east monsoon, but a bank is forming on the south-east elbow, or outside the south-east elbow, at a distance from the pier itself.

1386. (*Sir John Coode.*) When was that first discovered?—I have watched it for several years.

1387. You have been aware for several years that such a bank has been accumulating?—Yes, when I say "accumulating" I have not been able to detect the operation of it yet; but I have constantly mentioned it to Mr. Thorowgood and to the Governor.

1388. I do not quite understand you when you say you have "not been able to detect the operation of it"?—I will tell you how I detect it. I see discoloured water coming along *here;* generally, when there is a very strong southerly current, you see a dark line of very discoloured water coming along from the southward. I send out my men, and they bring me in a bucket of *this* water, and a bucket of blue water from between that and the shore.

1389. (*Admiral Sir George Nares.*) There is blue water inside the discoloured water, is there?—Inside the discoloured water. Then, after leaving the water to stand for a time in a glass the blue water has very little to show in the way of sediment, but the other has generally (it is very difficult to estimate) a very large proportion of sand standing in the bottom.

1390. At that moment how is the current running?—From the south to the north.

1391. All day long?—All day long.

1392. With both tides?—With both tides, five months together. There is no lateral ebb or flow of tide in Madras.

1393. Is there not a retardation of the current at some portion of the 24 hours?—It is very difficult to detect it. It does not obey the law of tides. It does not correspond to our tide-table.

1394. You have not noted down when you have examined this water whether the currents from the southward were retarded or not?—I had no means of doing so.

1395. (*Sir John Coode.*) You spoke just now of this current of discoloured water coming from the southward?—Yes.

1396. It does not follow because it is coming from the southward that it does not pass on. I want to know how you are able to say, so positively, that sand is being deposited to the southward of the angle of the south breakwater. You said just now you detected its operation. What I want to know is, what evidence have you that the sand is accumulating there?—It must drop somewhere.

1397. But may it not pass on altogether; that is the point I want to ascertain?—On every part of the Coromandel coast, wherever there is an obstruction like this harbour, or a little knuckle of land standing out, the sand after forming up a little on the side, exactly like *this*, forms itself into sand banks which go out to the north-east, until they are prolonged indefinitely. It occurs at Porto Novo, Pulicat, Armeghan, and all other places; and the commonest law ought to teach us that it will follow here in the natural course of things. If a wreck was to fall upon *this* part sand would be accumulated upon that very soon, and the wreck would raise it up a few feet in a few weeks.

1398. (*Chairman.*) You mean that that would arrest the sand by reason of the current?—Yes.

1399. Is any part of that current of sand being now arrested?—That I cannot tell. There is always this ground swell there, and it is next to impossible to get good soundings.

1400. We have seen a plan in which that has been marked as actually accumulating at the south-east knuckle, but in the plan you have handed in there is no notice taken of it?—No; that was done by Mr. Thorowgood for the purpose of this meeting *here*, but I think Mr. Thorowgood will say that it is next to impossible to get soundings. It must be a very nice calculation at first. It is only a few years now that this projection has been made; but that it is obeying the law of nature all along the coast is as clear, to me, as the sun in the heavens.

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1401. (*Admiral Sir George Nares.*) During the southerly monsoon how high would the swell be—the finest time of the year?—Several feet.

1402. Can you give us any idea what it would be outside the harbour by the wash up against the pier?—It gets thrown off there, but from the working of the sailing boats out there I should say it would be at least from 2½ to 3 feet.

1403. But surely we can obtain soundings when there is only a "sand" of 2½ or 3 feet?—Yes, if you knew exactly what the depth of the water was, but the depth of water is affected by the current also. Sometimes, when it flows in great force, it is retarded.

1404-5. If we have a chart put before us with soundings marked down, surely we are not to question it; they have been obtained properly?—I do not think any man would dare to sail his ship within 3 feet of the sounding on a chart in the open. I may just as well say that a day or two before I left Madras I saw Captain Carpenter of the "Investigator." I think he served with you?

1406. He is the head of the Marine survey in India, is he not?—He is at the head of the survey in India. He made this remark to me, he said: "Surely the people "in connexion with the harbour will not overlook this "fact which I see now all along the coast, that wherever ground has projected a sand bank has formed "in course of time."

1407. Had he ascertained that by sounding?—I do not know. He merely made the remark to me in conversation.

1408. Was his vessel employed sounding or surveying on that part of the coast?—No, the Seven Pagoda reef. He merely judged from other places.

1409. That was a matter of opinion?—"From observations I have made over the coast," he said, "I think that is a matter that ought not to be overlooked." That is the ground I go upon, because I admit we have no means of making accurate measurements *here*. We see the same thing going on a little higher up, but we may look upon it as a law of nature in that case and take some measures to guard against it *here*.

1410. (*Chairman.*) If the bank once commenced *here* there can be no doubt that it would occur. There can be no doubt about that.

1411. And it would increase more rapidly, of course, as it went on. I mean the ratio of increase would also increase?—Any little obstruction would magnify it very greatly. In all these other cases of Pulicat, and Armeghan, and so on, there is an opening with deep water between the shore and the shoal exactly like this, owing to the effect of the north-east current coming round and cutting out *this* part.

1412. In the case of the Madras harbour works does the north-east current cut away the sand deposited during the south-east monsoon on the south side of the harbour?—Very little indeed. It will sometimes force its way in. A very short time ago Mr. Grant Duff built a beautiful marina down a little way south *here*, and there were some puddles and things left there, and on a comparatively rough day he had the whole of *this* cut away, the sea came up and washed away the whole of his new garden. In the corner (D) at the back of the south pier the drift sand has come up to such a height that it would be very difficult indeed for the sea to come in unless it had some opening behind to communicate with it.

1413. (*Admiral Sir George Nares.*) Have observations actually proved that a bank is forming at the knuckle of the south pier, or is it only a matter of opinion that it will form?—I do not know whether it has been noticed by anybody else.

1414. When you say "noticed," have you noticed it by observations?—Yes.

1415. And actual soundings taken showing that the water is silting up there from 7½ fathoms?—No, I have not done that because, as I say, the operation at present must be very slight indeed.

1416. Then it is your opinion that it is forming?—It is my certain opinion that it is forming, and that opinion is based upon what I saw all along the coast in other similar situations.

1417. But no actual measurements have been obtained by you?—No, not that I am aware of.

1418. With regard to the tranquility of the water inside the harbour, your evidence is that the harbour, as designed, will remain incomplete as regards commercial facilities?—Yes.

1419. And that the great want is completely smooth water for commercial facilities inside the harbour?—Yes.

1420. And that it must be provided before the harbour is a success?—Yes.

1421. (*Sir John Coode.*) Following that up, your opinion is that the only way of making that provision is by closing the eastern entrance?—Closing the eastern entrance.

1422. Are you quite clear that that would do it?—Quite clear.

1423. Do you think the harbour would be, for all practical purposes, sufficient to carry on trade without inconvenience?—Quite so.

1424. And you would construct the works within the harbour along the shore?—I would commence at once.

1425. And you think that it would be smooth enough along-side those walls, or jetties, or whatever they might be, to carry on trade?—Yes, I am certain of it. At present the Port Trust are obliged to run tram lines along *here* to discharge the cargo on the bare beach in order to relieve the inner end of the pier.

1426. (*Admiral Sir George Nares.*) Because of the large quantity of traffic?—The immense quantity of traffic. A man lands a steam boiler at *this* end and perhaps will not take it away for five or six days. We cannot prevent him landing his boiler. The Act allows him to do it, and all the railway stuff is landed *here* now. We are running tramways along *here* to carry the heavy weights away and shunt them on to the beach until their masters choose to take them away; but all that would be obviated if we put down jetties, on which the lighters could land their goods direct at different places along the beach. *Those* are my original jetties that I ran out. They were swept away altogether on that occasion when the wall fell.

1427. (*Sir John Coode.*) Had they been brought into operation?—No, they had not gone far enough for that.

1428. Neither of them?—Neither of them; only the first rubble portion was up.

1429. (*Chairman.*) Can such a thing as a steam boiler be landed on the beach now?—Sometimes we manage to cover them up and float them, but very rarely. Most of them have to be landed at the end of the pier. We have done that with very heavy boilers. We have contrived to stop up all the man-holes and things, and float them ashore, but they are very liable to get damaged by bringing them up the beach. There was a ship the other day anxious to go away—the weather looked very threatening; she had nothing left to discharge but one big boiler, and the captain very coolly put it out in the water, anchored it, and left it there and went away. There it remained for three or four days, until the weather got fine. All that would be obviated if we could utilise the beach.

1430. Did you think, when it was first proposed, and when it was being constructed, that the harbour which was destroyed would afford protection to ships in bad weather?—No, not in bad weather. I never thought it would stand.

1431. Do you think that the harbour that you propose would afford protection to ships in cyclone weather?—No. The cyclone weather, I need hardly tell you, gives certain intimations of what it is going to do. When I see the weather threatening I telegraph down to Trincomalee, Pondicherry, and all that direction, and from the information they give me of the wind and the description of the sea, I can generally spot where the hurricane is with tolerable accuracy, and advise ships to come in or stay out according to the danger, but they are still exposed to the ground swell; no one can avoid that.

1432. Supposing the harbour to be reconstructed, with the entrance in the north-east corner, do you think that it would be safe for ships to ride out a cyclone?—No, not if the storm is coming on the place.

1433. (*Admiral Sir George Nares.*) Even then they will have to go to sea?—If the hurricane appeared to be out in the bay and going well to the north or well to the south they would be just as well *here* as anywhere else.

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1434. (*Sir John Coode.*) In the case of such a cyclone as that of November 1881, and with a north-east entrance, would they still have to go to sea?—Yes, I should think so.

1435. (*Chairman.*) The centre of that storm did not pass over Madras, did it?—No, it passed south; near the Seven Pagodas.

1436. (*Sir John Coode.*) Then you think there is no practical means of forming a harbour at Madras within which vessels may remain during a cyclone?—No, not in which it would be wise for them to remain, but that occurs so seldom.

1437. Once in 10 or 12 years, I think?—Yes.

1438. Is that about the average rate?—About 11 years, I think. The danger they would encounter would not be from the wind but from collision one with another. That is quite a separate thing, and has nothing to do with smooth water or anything else. It is simply that they are in one another's way.

1439. (*Chairman.*) Do you think that with the harbour reconstructed, with the entrance from the north-east, it would give sufficient protection to the small craft, steam-tugs, dredgers, and cargo boats?—Yes; they would never have occasion to go out; they would be all quite safe.

1440. During the construction of the works was it not frequently necessary to send some of the craft used in the construction away to some other place for shelter?—The two hopper barges were sent away once to Coconada. They wanted painting as well, and it was a good place to do them at.

1441. How far is that?—240 miles.

1442. It is too far off to become an ordinary harbour of refuge?—It is too far off to become an ordinary harbour of refuge. A thing like a hopper barge would go up the river, but steamers would have to lie three or four miles off.

1443. Tugs?—Tugs drawing more than seven feet cannot get over the bar.

1444. (*Sir John Coode.*) Do you approve of raising the walls to the height of 12 feet above the sea level?—I would rather not see it done at the north side, but on the sea face I would certainly approve of it, provided there is enough breakwater.

1445. (*Chairman.*) Speaking on behalf of the Harbour Trust, would you say that no idea of an entrance at the south-east corner is entertained?—No, they all recognise the impossibility of it. It would be only a temporary thing.

1446. We have it in evidence from one authority that, supposing the harbour to be reconstructed, with an entrance at both corners, there would be shelter enough for a steam dredger inside which would suffice to keep a south-east entrance clear; that it is a question of shelter for the dredger?—The difficulty of the south entrance is that there is no room for a ship to manœuvre. There is a sand bank comes out on the south side; on the north side you have deep water; 3 fathoms close in, and about 4½, or so, not far out, and 6 fathoms. You have ample room to manœuvre a ship, and southward more at will. That is a growing evil.

1447. (*Sir John Coode.*) What you mean, in fact, is that if it does not grow out from the shore it will grow in the form of an isolated bank at the knuckle of the southern breakwater?—Yes.

1448. (*Chairman.*) Then we may understand that the idea of opening an entrance there has been abandoned?—I did not know it had been entertained, but I can imagine no use in a southern opening.

1449. (*Sir John Coode.*) Did I rightly understand you just now to convey to us that the sand, having grown out on what was originally the five-fathom line, has now ceased to advance from the shore, seaward, but that in lieu of that it is growing up outside?—Yes, that is my idea.

1450. You think it has ceased to grow?—Yes, certainly; down by the Coom, about three miles down south, opposite the battery, there is a tolerably broad bank of sand that constantly changes. The battery was nearly cut away two years ago, but, to look at it now, you would think the sea would never come within hail of it; it changes. A north-east storm, for instance, would cut away a lot of *this*.

1451. If the storm was from the southward?—We never have a storm from the southward. With a wind from the southward the storm would be already inland.

1452. But with a current from the southward?—It is a wave that does the mischief. As long as the waves are clean they go along very rapidly and very steadily, but the moment they touch the shore and lick up the sand they get heavier; the consequence is they go heavier and solid, and leave a deposit as they go, so that the rougher the sea, joined to the effect of the current, the greater is the operation on the shore.

1453. (*Admiral Sir George Nares.*) Are there any authentic observations, showing that the foreshore has ceased to advance on the southern side of the pier?—I have not taken any observations myself. Mr. Parkes, I suppose, gets his reports from Mr. Thorowgood. We constantly walk out *here*, and we do not think it has moved for some time—just about opposite the end of the pier.

1454. When you say "for some time," for how many months?—Oh, say for a year and a half.

1455. (*Sir John Coode.*) Then as regards the growth to the southward of the south pier, you would rather that we rely upon the observations made by Mr. Thorowgood than upon the general opinion that is given by yourself; that I understand to be the drift of an answer you gave just now?—Yes, I am morally certain of it, but we asked Mr. Thorowgood the other day the question (I rather think he wrote to Mr. Parkes to the same effect). He said: "As things are at present "you cannot depend on soundings to such a nicety "as is required to answer the question definitely."

1456. Still, if the soundings he has furnished do show a result, do you think we might rely upon it?—Certainly.—I think nature supplies it besides in all the other places.

1457. (*Chairman.*) Do you not realise that until that north east entrance is sufficiently open to admit ships, you must keep the eastern entrance open?—Yes, on the plan we propose it would not take long to clear the north east opening, and then they could both be used until the other was closed. There is only broken *débris* showing above water, and dynamite would very soon reduce that. The depth outside, where we propose that the mouth of it should be, now is 7½ fathoms, and we only want 30 feet for the ship, with *this* protecting arm, so that that leaves 15 feet in which the *débris* can be spread about by dynamite without requiring dredging away.

1458. Then you would not propose to pick it up?—Only if it is found necessary. It would be cheaper to distribute it, but that is an engineering question, and I can only offer an opinion upon it.

1459. (*Sir John Coode.*) Is there any other point you would wish to bring to our notice before we enter upon the documents of the Port Trust?—There is only this matter: This harbour is unquestionably small, and there is reason to hope that the Madras trade will improve. When the Buckingham Canal is brought into the harbour, and when the beach is safe enough for boats to lie in the harbour, we hope that additional facilities will be given, and that ships will no longer suffer any delay in coming in and going out, and that the trade will therefore increase, in which case, *this* little basin of water will not be large enough. No increase could ever be obtained on the south side, nor would it be wise to carry it out further seaward, because it would make the work further from the beach, but if the seaward wall and north arm were carried out as proposed, *there*, and another arm corresponding to A and B, could be extended to any distance you please from the shore, and protected by the increased north arm so as to give another close harbour and a large quay where the present north wall is. That would be useful, and might immediately come into operation for ships to lie at, but in no other way could you increase the harbour. Undoubtedly it is a small harbour now. It is an important question for Madras, because it involves the question whether the harbour can ever be increased or not; and the prospect of increased prosperity of the port depends upon this.

1460. (*Chairman.*) The letter that you handed in (the "extract of proceedings of the Harbour Trust Board") speaks of four different plans, of which the one that you have put in is No. 3?—Yes, No. 3.

1461. Putting aside the question of fortifications, this extract from the proceedings of the Harbour Trust

Capt. J. H. Taylor. 8 June 1887.

Board, dated the 29th April 1887, provides for entirely removing the *débris* of the old wall from the present entrance up to the proposed end of the north pier. Will that be necessary for the entrance of the navigation harbour?—No; you need not move that corner that I have marked out there,—that might be utilised for a battery.

1462. Not the whole of it?—No.

1463. (*Sir John Coode.*) Are to we understand that these documents you now hand in to us as coming from the Madras Harbour Board contain the view which they wish to place before us with regard to the question now at issue?—Yes.

1464. We are to accept these as containing the view of the Harbour Trust. They have entrusted them to you to place before us as their view of the question now at issue?—Exactly.

The following are copies of the documents handed in and read.

EXTRACT of PROCEEDINGS of the Harbour Trust Board at a meeting held at the offices of the Board on Friday the 29th day of April 1887.

Present:

The Hon. R. W. Barlow, C.S., Chairman.

The Hon. S. R. Turnbull.
Mr. J. McLintock.
Mr. G. L. Chambers.
Mr. J. R. Hunter.
Mr. G. D. Coleman.
Lieut. J. H. Taylor, R.N.R.
Captain W. L. C. Baddeley, R.E.
Mr. George King.
Mr. Cowasjee Eduljee Panday.
V. Mahomed Shereiff Sahib Bahadur.
M. R. Ry. S. Vencatakistnamah Chetty Garu.

In opening the proceedings of the meeting the chairman stated that in accordance with the resolution No. 2 passed by the board at their last meeting a telegram had been despatched to Government regarding the wish of the board to be represented upon the Committee now sitting in London, to discuss the question of changing the place of entrance to the harbour, from the east face to the north-east corner; that a telegram had been received from the Secretary of State in reference thereto; and that Mr. Thorowgood, who was present, would explain to the board certain suggestions he had to make, with regard to what, in the present condition of the harbour, he considered the best plan for carrying out the wishes of the board for a north-east entrance.

The secretary then read the telegram dispatched to the Chief Secretary to Government, after last meeting, stating that "At meeting last evening read G. O. 1001 "Works. Resolved that the board are unanimously of "opinion that the Trust should be represented upon "the London Committee appointed to consider the "question of the north-east entrance to the harbour. "The board suggest that Captain Taylor should be "appointed to represent them, and that the proceed"ings of the Committee be stayed by telegraph pend"ing his arrival," and read also letter from the Chairman No. 383, dated 25th April, addressed to the Chief Secretary, confirming the telegram, and further explaining the board's wishes.

Read telegram from the Secretary to Government, Public Works Department, dated Ootacamund, 28th April 1887, stating: "Taylor permitted by Secretary "of State to go home next mail as witness, not as "member of Committee, should take statement from "board on following points:—whether in opinion of "board north-east entrance is essential; best means "of carrying out this object, and whether board think "any change in sanctioned design is desirable, and if "so, what change."

Resolved, first, that the board unanimously adhere to their former resolution No. 2, dated 16th December 1886, that a north-east entrance is absolutely essential to the success of the harbour.

The superintendent then submitted a plan showing marked respectively in blue and yellow lines and in red tint:—

In blue No. II., the plan submitted with his letter No. 600 M., dated 31st January 1887.

In yellow No. III., an entrance immediately adjoining the present termination of the new work on the northern arm.

In red tint No IV., an entrance approximately from half-way between the north-east angle of the northern arm and the existing opening.

The superintendent explained that to carry out plan No. II. would necessitate the removal of the whole of the work built at the north pier during several months past, involving the removal of thousands of tons of material and great delay.

That plan No. III. would also necessitate considerable delay, and as the site of the proposed north-east entrance must be open before the present one could be closed, it was necessary, in this plan, to entirely remove the débris of the old wall, from the present entrance up to the proposed end of the north pier, before the southern arm could be brought across, and be allowed to close the present entrance; this would occasion great delay in protecting the existing harbour upon the northern half of the eastern face.

No. IV. in red tint. This plan has the advantage of enabling work to be carried on without interruption upon the present plan, until the southern arm reached the existing opening, by which time the northern pier would have advanced sufficiently to itself afford considerable protection to the enclosed space, the portion of old wall it would be necessary to remove could by then have been cleared away, leaving the proposed opening free from all obstruction, and it would only then remain to advance the southern arm in a direct line across the existing opening to the position shown, to afford exactly the same protection to the enclosed space as was provided in the plan submitted with his letter No. 600 M., dated 31st January 1887, the relative positions of the pier heads of the northern and southern arms in each plan being identical. This plan No. IV. had the advantage also of carrying the entrance further to seaward, giving a minimum depth of eight fathoms in the entrance and from the proposed line the southern arm would take, enabling vessels to enter from a more easterly position, thereby allowing them to keep much farther to seaward, and clear of the line of rollers upon their full length.

The matter was discussed at considerable length, and the superintendent stated further that with regard to the cost of the respective schemes, No. IV. would be more economical than No. II., but that he had not prepared an estimate for design No. III., the cost of which would probably not differ greatly from the cost of No. IV.

Captain Taylor suggested that the difficulty might be overcome by making an entrance in shore of the north-east angle of the northern arm, continuing the works on the existing plan, which plan would involve no delay, be economical, and have only the disadvantage of placing the entrance nearer in shore than the proposed entrances Nos. III. and IV.; he pointed out that against this disadvantage it must be remembered that the sea to the north of the harbour always retains its present depth, and is amply sufficient for all practical purposes. It was, however, considered by the board, that the near vicinity of the shore was a fatal objection to this proposal.

Resolved, secondly, with regard to the best means to be adopted, that the board, after examining the several plans submitted by the superintendent, consider the designs Nos. III. and IV. would be the most suitable; subject to any modifications that the Home Committee may make, the board consider it undesirable to take up more than is absolutely necessary of the work already built.

Resolved, thirdly, that in the opinion of the board the sanctioned design should be altered only in so far as is necessary to provide a north-east entrance without taking up more than necessary of the work already built.

(True extract.)

C. PINSENT,
Secretary,
Harbour Trust Board.

Capt. J. H. Taylor. 8 June 1887.

EXTRACT of PROCEEDINGS of the Harbour Trust Board at a Special Meeting held at the offices of the Board on Tuesday the 3rd day of May 1887.

Present:

The Honourable R. W. Barlow, C.S., Chairman.

The Honourable S. R. Turnbull.
Mr. J. McLintock.
Mr. G. L. Chambers.
Mr. J. R. Hunter.
Mr. G. D. Coleman.
Lieut. J. H. Taylor, R.N.R.
Captain W. L. C. Baddeley, R.E.
Mr. George King.
Mr. W. J. Eales.
Mr. Cowasjee Eduljee Panday.
V. Mahomed Shereiff Sahib Bahadur.
M. R. Ry. S. Vencatakistnainah Chetty Garu.

Read G.O. No. 1179 W., dated 29th April 1887, communicating telegram from the Secretary of State, dated 27th April 1887. "Harbour Committee already formed "and at work. Admiral Salmon, Nares, and Coode, "but Taylor may come as witness," and stating that Captain Taylor should be instructed to proceed to England by next mail, taking with him a statement of the views of the board on the leading principles upon which the work is in future to be carried out, and should clearly understand to what extent he is authorised to pledge the board before the Committee.

Read letter No. 469, dated 2nd May 1887, from the chairman, Harbour Trust Board, to the superintendent Madras harbour works, communicating the resolutions of the board respecting the proposed north-east entrance at their last meeting, and requesting that he would draw up a memo. explanatory of the various designs then submitted by him.

Read the superintendent's reply thereto, No. 108, dated 2nd May 1887, and descriptive memorandum annexed. Examined plans Nos. I., II., III., and IV. therewith submitted.

The trustees then proceeded to the head of the northern arm of the harbour, and held a consultation with the superintendent, and after discussing on the spot, at considerable length, the respective designs for a north-east entrance, returned to the board's offices.

Read the minutes and confirmed the proceedings of the last meeting of the board having reference to the question of the proposed north-east entrance, and resolved that, having now examined the spot, the board are unanimously inclined to give the preference to design No. III. on the grounds that it will give within the harbour a larger area of deep-water anchorage, and that it will facilitate the exit, entrance, and mooring of vessels.

A copy of the board's proceedings will be communicated to Captain Taylor for his information and guidance.

(True extract.)

C. PINSENT,
Secretary,
Harbour Trust Board.

No. 499.

Harbour Trust Board Office, Madras,
4th May 1887.

From the Honourable R. W. Barlow, C.S.,
Chairman, Harbour Trust Board,
Madras.

To Captain J. H. Taylor, R.N.R.,
Madras.

SIR,

I have the honour to forward copy of G.O., No. 1179 W., dated 29th April 1887, as well as of the resolutions of the Trust noted in the margin,* for your information and guidance.

2. I also hand you herewith the tracing of the harbour, showing the various designs for a north-east entrance which was before the board at their meeting of 29th April 1887, and the four sketch plans, Nos. I., II., III., and IV., taken therefrom, submitted by the superintendent with his letter No. 108 of 2nd instant, copy of which, together with the explanatory memo. therein referred to, is herewith forwarded.

3. I think these papers will clearly put you in possession of the views of the Harbour Board, so that you will be able to explain them to the London Committee.

4. The trustees, while approving of designs Nos. III. and IV., prefer the former, for the reasons stated in their resolution at their meeting last evening. You will also observe that they object to any scheme that would bring the entrance nearer to the shore, *vide* their proceedings of the 29th April 1887.

I have the honour to be,
Sir,
Your most obedient servant,
R. W. BARLOW,
Chairman, Harbour Trust Board.

No. 108.

From the Superintendent,
Madras Harbour Works.

To the Chairman, Harbour Trust Board,
Madras.

Madras, 2nd May 1887.

SIR,

In reply to your letter of this date, No. 469, I have the honour to submit the following:—

2. I send herewith a tracing similar to that which was before the board on April 29th, on which are shown—

Proposal I. (Madras Committee, 1883), red lines.
" II. (Superintendents' modification, 1887), blue lines.
" III. (Alternative proposal by superintendent), yellow.
" IV. (Alternative proposals by superintendents), red tint.

I also, for clearness sake, forward a small plan of each of these designs separately, marked I., II., III., IV.; with these plans is a short descriptive statement of each, which I trust meets the requirements of your paragraph No. 2.

3. In reply to your third paragraph, I am inclined to prefer the (No. III.) design in yellow lines for many reasons, but there is a strong objection against it practically, namely, that it involves deciding *at once* on stopping work at the north pier, whereas, with design No. IV. (in red colour) work could go on during June and throughout the season as before. This, with all the machinery and diving staff on hand, and with blocks ready for another 150 feet of north pier, is a very serious consideration.

4. I must ask you to record, and I should like the Committee in England to be aware, that I do not myself wish for a north-east entrance, nor do I think it essential to the success of the harbour. On the contrary, I do not at all feel sure that, in a heavy rolling swell, vessels would not feel a north-east entrance worse to navigate than the easterly one, as they would enter with their length parallell to the crests of the waves.

Moreover, as I have stated before, I cannot but believe that those who so strongly advocate closing the eastern entrance forget what this harbour was like in September 1881, when some eighteen native craft, some of large size, anchored comfortably in the northern half of the harbour, and two large sailing ships* lay calmly at moorings in the southern half. At this time the entrance was 100 feet wider than the proposed eastern entrance will be, and the walls were six feet lower than those now proposed. Doubtless a north-east entrance will give smoother water, but at a cost of some 20 lacs of rupees, and, to my thinking, of a very doubtful entrance. I therefore must record that I should prefer adhering to the design of August 1884, now under consideration.

I have the honour to be,
Sir,
Your most obedient servant,
(Signed) F. N. THOROWGOOD,
Superintendent, Madras Harbour Works.

* 29th April 1887. 2nd May 1887.

* "Mars" "Nofossilite."

Capt. J. H. Taylor.

8 June 1887.

Madras Harbour.

DESCRIPTION of different proposals for a north-east entrance to accompany plans and tracing.

Proposal No. I. (*In red lines* on tracing).

This is the design proposed by the special committee in Madras, 1883, and reported unfavourably upon, by Sir John Hawkshaw's Committee, 12th March 1884, in Westminster.

As proposed by the Madras Committee it was supposed to be built of random blocks, over the existing lines of ruined piers. At the present time such a system is out of the question, as the plant is not adapted for such work.

The objections to this design are, (1) that 400 feet of the newly built work, with wave-breaker complete, would have to be taken up; (2) that the concave arm towards the east is a weak point; (3) that two entrances will have to exist at the same time; and (4) that its cost is too great.

Roughly speaking, the cost of this scheme (now that the entrance is nearly closed) I estimate at rupees 65,47,000 as compared with rupees 45,90,951 of the design now under construction.

Proposal No. II. (in blue lines on tracing).

Is a modification of the above, so as to avoid the concave curve. I estimate its cost at rupees 66,00,000.

Proposal No. III. (in yellow lines on tracing).

This design does away with the necessity of taking up any of the new superstructure work, and proposes to build a pier-head at the present termination of the new work, north pier. At the same time it means suspension of work at this pier, and consequent slow progress at one pier only.

The south pier is to be carried across the eastern entrance, and extended, as shown.

The drawback to this design is that the whole of the ruined work and much of the new rubble base has to be removed, and for a time the harbour would be perfectly open to the north-east.

I estimate the cost of this design at rupees 61,00,000.

Proposal No. IV. (in red tint on tracing).

This is the plan which finds most favour with the Harbour Trust Board. Its advantages are (1) that only a very small portion of the old ruined wall and rubble have to be cleared away; (2) that during construction there will never be more openings than the proposed entrance through which the sea can come; and (3) that it allows of work being proceeded with, as at present, at least for four months or more.

The cost of this design I estimate at rupees 62,95,001.

(Signed) F. N. THOMWSOON,
Superintendent Madras Harbour Works.
Madras Harbour Works Office,
2nd May 1887.

Public Works Department.

Proceedings of the Madras Government.

Read the following papers.

Telegram from Captain Taylor, Port Officer, Madras, dated 22nd April 1887.

Telegram from the Chairman, Madras Harbour Trust Board, dated 23rd April 1887.

Endorsement from the Marine Department, dated 23rd April 1887.

Telegram to the Secretary of State for India, No. 46 D., dated 26th April 1887.

Telegram from the Secretary of State for India, dated 27th April 1887.

"Harbour Committee already formed and at work. Admiral Salmon, Nares, and Coode, but Taylor may come as witness if you think it desirable."

Order thereon, No. 1179, dated 29th April, Public Works.

The telegram from the Secretary of State will be communicated to the Chairman, Madras Harbour Trust Board, with reference to his message of 23rd April 1887.

2. Captain Taylor should be instructed to proceed to England by next mail from Bombay, and should be furnished with a statement from the board of their ideas on the leading principles upon which the work in future is to be carried out, *e.g.*:—

(1.) Whether a north-eastern entrance is essential.

(2.) The best means of carrying out this object.

(3.) Whether it is desirable to make any change in the present design, and if so, what change?

Captain Taylor should in fact clearly understand the board's views, and be instructed to what extent he is authorised to pledge the board; and, in examination by the Committee, should be careful to distinguish between the board's views and his own.

(True extract.)
(Signed) J. O. HASED,
Colonel, R.E.,
Secretary to Government,
Public Works Department.

1465. (*Chairman.*) This No. 3, being the scheme adopted by the Harbour Trust Board of Madras, differs to a certain extent from the plans we have had before us for opening an entrance to the north-east, but as a matter of work in making the alteration, and of expense, there is very little difference between them; therefore from that point of view they may be looked upon as identical. Can you give the Committee any idea how it is proposed to carry out that work?—The Committee do not consider themselves engineers in any way; they only select this as a plan that will suit their necessities. There is no difficulty. The only thing is they would have to put as much force as they could on the east side, or the eastern face of the south arm; but, instead of employing divers and others, who are now employed in carrying on the north wall, it would be necessary to employ them in the removal of the broken ground. I dare say it would be quite possible to float the tiles.

1466. My question points to the necessity of keeping open the eastern entrance until that protecting arm is completed—that is, until what we may call the north-eastern extension is completed, and what we should like to know is, how you propose to build that north-eastern extension without completing the work that is now being carried out?—Simply by employing all the force that can be employed to carry on the work as rapidly as possible.

1467. You cannot carry it over the mouth of the harbour?—Yes; the new one would be open long before they got *there*. Mr. Thorowgood's objection is that he does not like to get rid of his staff of divers, and other people. I do not know why, but for some reason of that sort.

1468. I do not think we have anything to do with that.—They could be very easily employed in removing *this* broken portion, so that in the course of one year you would have two openings.

1469. I am to understand that you would start opening that north-eastern entrance before you have the protecting arm?—Yes, certainly. We would be no worse off than we are.

1470. (*Sir John Coode.*) Your point is, as I understand it, that it is all open now?—That it is all open now.

1471. (*Chairman.*) It is not open to the passage of ships?—Oh, no, but we could do that. Then in the course of a year, supposing Mr. Thorowgood had got somewhere near the old opening on the south side, *this* north one would be ready, and the pilot could make his choice whether to come in *there* or *there*, until *this* one was closed. As a question of shipping, I do not think we ever entertained the idea of any difficulty, or anything of the sort. There is the harbour, and the ships will be got in.

1472. In opening that north-east corner as you propose, at once, you would let in the sea in two places instead of in one?—No; it is let in now all the way from *here* to *here* (*pointing to the plan*).

1473. It is only surface. I am speaking about the ground sea?—The ground swell is all surface.

1474. What is the depth of water now over that part of the north-east corner which you propose to remove?—It varies, I suppose. In some cases you see little blocks sticking up; in other places, where boats go through, there is 12 or 14 feet of water.

Capt. J. H. Taylor.

8 June 1887.

1475. What is the greatest depth, should you think?—That I do not know; I have not sounded. Mr. Thorowgood could tell you. He is filling it up now with rubble as fast as he can.

1476. As I understand, it is filled up with rubble. All the rubble is there that is going to be there?—No, not quite all that is going to be there. We have got a good portion of rubble thrown down *there*.

1477. (*Sir John Coode.*) Do you think, in view of the strong opinion expressed by the Harbour Trust, which we have just had read, that he is still continuing that rubble base?—He is not doing anything now.

1478. Do you think that he will?—A telegram will stop him going on with the north arm.

1479. Do you think that if a telegram is not sent him he will proceed?—I do not know. When I left the question was not settled. Whether he was under any orders from Mr. Parkes or not I do not know.

1480. (*Chairman.*) We have had it stated in evidence that the rubble part of that reconstruction is completed?—I have not seen that in evidence anywhere.

1481. I say we have it in evidence. Now, what is the depth of the water over that rubble bank?—I cannot say. I do not think that can be the case, because you see the broken blocks that are left. He crushes them, and blows them about to help make the rubble base. The depth is practically 20 feet.

1482. What water would you require?—Say 30 feet after the arm was protected.

1483. Would not increasing the depth of water over that face to 30 feet very materially increase the effect of the swell in the harbour?—No; I do not think it would. I do not think it would make any difference in that way.

1484. Then we are to understand that you see no disadvantage in leaving, I may say, the whole of the defensive works from the north-east corner to the end of the south pier, open, over what at present exists?—We cannot help ourselves if the opening is *there*. There is no difficulty about it, except that in some days of the year the ships cannot come in. Some nights they have to go out; but *there* is the opening, and until it is closed, of course it can make no difference to us.

1485. It makes this difference, that at present you are rapidly closing up the harbour, and that some considerable time after deciding on the change you propose, you would open it at the north-east corner?—You mean that we should suffer any inconvenience from it?

1486. Yes?—That we do not consider worth considering, because we can do nothing on the beach to facilitate the trade of the place until we get *this* eastern opening closed. At present the facilities are almost as great at Madras as in any other port, except that ships now and then have to slip and cut out of the place; and on some few days boats are not able to work; but we cannot work on the beach. They cannot effect any improvements on the beach until they get smooth water; and if it takes a year or so longer, they look upon that as a minor inconvenience.

1487. And to arrive at that you are prepared to put up not only with a very large expense, but a certain additional inconvenience?—There is no additional inconvenience.

1488. That you do not admit?—I do not admit that there would be any inconvenience more than there is at present. The workmen employed now *here* would remove *this* broken *débris*, and whatever rubble might be above the proper mark; and Mr. Thorowgood would carry on his wall *here*.

1489. (*Sir John Coode.*) Do you think that deepening that rubble base down to 35 feet would not admit a greater amount of sea into the harbour than at present?—I do not think so. The sea that comes in is surface. It is the current that cuts out the rubble underneath.

1490. (*Chairman.*) Admitting that you have to remove that rubble, can you give any idea how many months in the year the divers would be able to work at it?—On work like that, not involving danger, they could work the greater part of the year, all but perhaps, say one month.

1491. How do you mean "not involving danger"?—The danger to the divers now is in getting among these blocks. They would not have to do that in simply removing the rubble.

1492. (*Sir John Coode.*) The air-pipes are liable to get entangled. I suppose that is the danger?—Yes: and they knock about more. If it was not for the diving the work would be done in a very short time. There are many days on which the divers cannot work in the ordinary way, but still on those days they could work at getting the rubble up, that is, so long as they were not exposed to the danger of being caught and hurt among the blocks.

1493. (*Chairman.*) You could not give an idea of to what extent that work would be interfered with by the weather, could you?—In fine weather there would be no delay at all.

1494. I mean in the course of the year?—In merely getting up the small stone rubble I do not think there would be one month in the year when they could not work. They would get the protection of the old blocks besides.

1495. Have you ever considered whether it would be worth while to give up the use of the harbour entirely for a time so as to fill up the eastern entrance at the same time that you are opening the north-east entrance?—You could not. You would stop all the trade of the port.

1496. You think the trade of the port could not be carried on outside, as it was formerly?—No, not now. Ships would not come there. And I cannot imagine any case in which it would be necessary to do that.

1497. You mentioned when we were discussing the plans that the whole of the old work on the sea face is subsiding, did you not?—Yes.

1498. Can you give us an idea to what extent it has subsided since the storm?—No, I cannot. I only know that we all watch it.

1499. Can you point out to us what the soundings are on the old works?—They differ every five or six feet.

1500. (*Sir John Coode.*) You do not mean to convey to us that the work is actually settling down, do you?—No.

1501. I suppose you mean that the blocks are being scattered?—No; pieces that used to come above water are now under water.

1502. They are scattered by the sea?—They may be scattered by the sea, or they may have subsided. That is a matter for Mr. Thorowgood. It is a curious thing that at the south-east corner—the south-east angle *here*—a very large amount was displaced bodily during the last rough weather.

1503. (*Admiral Sir George Nares.*) In what monsoon?—In November.

1504. (*Sir John Coode.*) Last year?—Yes.

1505. (*Admiral Sir George Nares.*) What monsoon would that be?—The north-east. It is not exposed to the danger that you would think the northern one would be, but, from whatever cause, there was a big gap *here*, I should say of 150 feet.

1506. In the upper blocks?—Not in the new blocks; in the old blocks. Some of them were in their old places and some were not.

1507. The upper blocks existing the month before?—Yes.

1508. Do you know with what effect upon the base?—No, I have no means of judging of that.

1509. (*Sir John Coode.*) Had the sea been very heavy in the meantime?—No.

1510. Then would it not appear that there had been some undermining of the rubble base to cause this?—That we always suspected. They are such small blocks that any current could walk away with them. The sea makes marbles of the stone, and then a rougher current than usual comes and rolls it away.

1511. And some of it is not quite so hard as it might be, is it?—The old work was just common laterite, and melted away.

1512. What are they putting in now?—Granite.

1513. Nothing but granite?—Nothing but granite. The small stones are carried by women and thrown in.

1514. Is there any proportion of small chippings?—No; the chippings are used for making the concrete.

1515. Is it all large rubble; such stones, for instance, as would require both hands to lift?—A woman would take one in her hands.

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1516. Is there any stone about the size of ordinary road material—what we call macadam?—No, not so small as that. It is all about *that* size (*describing*).

1517. When you say "about that size," I gather from your description that you mean about the size of a man's head?—About the size of a man's head, or smaller.

1518. Not much smaller?—Not much smaller and not much larger. There is no piece that a man or a woman cannot carry easily and throw in.

1519. And none much smaller than a man's head?—No, I do not think so. In Madras we have always had grave disputes about that small rubble.

1520. About its being so small?—Yes. It can be easily moved by the current. I do not myself put implicit reliance on the soundings and surveys that are reported, because the other day, in looking for some cargo that had gone overboard, we found a *pile* of the old pier.

1521. About where?—In the 6½ fathoms.

1522. Rather on the south side?—Rather on the south side of the opening. This was a large 45-feet pile. It was found out afterwards that it had slipped out of the slings during the original construction of the pier and gone down; and there it was stuck up in the sand; there was about 15 feet of it in water and the rest down below, and how ships could have gone in round this without hitting upon it we never could find out.

1523. Above the *débris* you mean when you say "above water"?—Yes, above the sand bottom. It is perfectly inconceivable how the surveyors, who had gone over every piece of the ground, did not find it, and what is more, how the ships did not come across it; but there it was. We tried several times with dynamite to remove it; we loosened it, and at last got it out. It was originally an 8-inch pile standing up 12 or 14 feet, leaving only 22 feet for ships to float in out of the 6 fathoms.

1524. But might it not be that that pile was standing at a very low angle?—No, it was upright.

1525. How was that ascertained?—By our divers who went down.

1526. You found it was upright?—Yes; we put bobs of dynamite round it in the sand and we could not lift it, but we shook it very much, and at last by the aid of a very powerful crane overhead we drew it up.

1527. (*Admiral Sir George Nares.*) Unless the surveyor's lead had actually hit upon the point of the pile, he could not have measured it, could he?—You cannot blame the surveyors for not finding it. It would be a very difficult thing for them to find it?—I do not blame them. It only makes me not place implicit reliance upon their knowing every inch of the ground as they say they do.

1528. But still, not finding a small pile like that would not lead you to discredit the whole mass of soundings, would it?—Oh, no, I do not say that. It was a most extraordinary circumstance.

1529. Have the Harbour Trust considered the length per foot run of base, and the extra material that would have to be provided for the proposed new plan over the other?—They have only taken Mr. Thorowgood's estimate.

1530. The financial estimate?—Yes.

1531. They have not gone into the question of the amount of work that will have to be gone through?—No; it is very cheap. The stone comes by train from Palaveram.

1532. What other change of plan has been considered for quieting the water in the Madras harbour other than blocking up the east entrance and opening the north-east one?—No other.

1533. No other change whatever?—No other whatever except the south entrance, which was abandoned.

1534. Has it ever been considered whether it would not be a cheaper plan, and better, to put an isolated breakwater outside the present eastern entrance, and covering it?—It would be exceedingly difficult for ships to get in unless it was very far out; and then it would cost a deal of money of course—far more than any other plan.

1535. Have you gone into what the cost of it would be?—No.

1536. If we find, with the proposal that is before us now, that there is 1,800 feet of extra base, and 950 feet of extra upper work, supposing we can put the same quantity of stuff 1,200 feet outside the present entrance, blocking it up altogether from the ground swell, what would you say to that plan, if it did not cost more?—Well, I should say it would be almost impracticable, from the difficulty of getting the concrete blocks out that distance, without any road to them. A totally different system of engineering would have to be adopted.

1537. The base work now has to be transported in barges, I suppose?—Only the rubble.

1538. Then the only difference would be that at present all the blocks are carried along the piers from the shore, and in the case of an isolated breakwater they would have to be transported in barges?—Yes.

1539. That would be extra expense?—That would be extra expense, and that again, as I have said before, would render necessary any project for enlarging the harbour, which could be very easily done by running out an arm northward and carrying the sea wall further on parallel to the beach. It will be necessary to enlarge the Madras harbour.

1540. Your evidence goes to say that any works that provide quiet water must be considered in connexion with the enlarging of the harbour in future?—Not necessarily, I did not say that.

1541. You have told us that the harbour is small, and that for the expected trade the harbour must soon be enlarged?—It must, in our opinion, soon be enlarged.

1542. Therefore the whole question that is before us of where the entrance is to be, must be taken in your opinion in connexion with that enlargement by and bye?—Yes, in my opinion, and the question of defences also. It must come to that.

1543. (*Sir John Coode.*) You have spoken this morning of a stream of discoloured water passing from south to north outside the harbour. Where does that discoloration cease?—It generally goes perhaps about a quarter of a mile.

1544. From where?—From the point where it begins. I can point it out.

1545. With relation to the harbour of Madras, where does that discoloration cease?—It seems to come in *this* way (*marking a plan*) and then stop.

1546. Then does this discoloured water travel to along the shore?—No; there is blue water all along between *this* and the Coom mouth.

1547. Then there is, in fact, a patch, and only a patch, of discoloured water?—A patch, and only a patch of discoloured water.

1548. A patch of discoloured water about two and a half cables length at the south-east of the knuckle of the southern pier?—Yes.

1549. And would you say that *this* sketch of yours describes it?—I would say that that is a very fair representation of it.

1550. That patch, as you have sketched it, is about three cables in length?—Yes.

1551. And it may be about a cable in breadth; would that be about it?—No, not quite so much.

1552. About three-quarters of a cable's breadth?—Yes.

1553. And that exists as an isolated patch of discoloured water?—Yes, but not always.

1554. No; I am coming to that. For how long will you see that—more than a day?—Sometimes two or three days running.

1555. And frequently occurring?—And frequently occurring during the south-west monsoon.

1556. How many days should you say during the south-west monsoon you would see a discoloration of that kind?—Taking the monsoon at five and a half months I should say you would see the discoloured patch there for three months, in the day time; I do not know what goes on at night.

1557. Then do you draw the deduction from the presence of that discoloured water that there is a sediment, or deposit, at that point?—Yes.

1558. (*Admiral Sir George Nares.*) Is there any similar discoloration opposite the north side of the harbour?—No, there it is all clear water.

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1559. What do you attribute this to; have you ever formed any theory?—I attribute it to some similar action as at Pulicat and Armeghan, where the sand having reached its limit on the projection, the cut of the north-east monsoon coming round keeps that passage open.

1560. The north-east monsoon! I thought you were talking about the south?—I am talking of the passage between the two. There is a passage between the two, which you will see at each of those other places, and which is owing, I say, to the north-east monsoon coming sharp round this corner *here*; then, the sand not being able to have, I suppose, the same opportunity of settling itself as it does at other times, forms a bank out *here*.

1561. (*Sir John Coode.*) Then you think that this discoloured water is due to an eddy of the return current?—No, there is no sand comes from there. The sand is all from the south.

1562. Why does it not appear more southerly than over the area which you have just described to us. Have you formed any opinion of that?—Yes.

1563. Why is not the discoloration visible further south if it is coming from the south, if the current is coming from the south?—It is caused in some way by *this* obstruction.

1564. That is your answer, that the obstruction which is caused by the south breakwater is really at the root of that discoloured water?—It throws it out in some way. The return eddy from the walls *here* in either monsoon throws out the sea; for instance, if you are sailing in a boat off the S.E. angle with the sea breeze, you get water on board that is thrown back from the lee wall.

1565. (*Admiral Sir George Nares.*) The current, striking up against the south pier, causing an off-set along the pier?—A very strong off-set along the pier.

1566. And that would disturb the sand at the bottom?—No; I think the sand comes from the south; but I think this eddy, the throw-off from *this* wall, may be the means of preventing the sand approaching nearer than I say it does, *there*.

1567-8. (*Sir John Coode.*) It is due in fact to the rebound?—Yes, it may be.

1569. (*Admiral Sir George Nares.*) There is not the same action with a northerly monsoon on the north side of the harbour?—No.

1570. Because there is deeper water there?—Yes; there is no sand on the north at all. It is revetted from *here* to one mile north. The discoloured water is, in my opinion, forming the shoal. I have written to the Government frequently about it.

1571. In fact, there is an increase in the strength of the current immediately at the knuckle of the south-east pier, caused by the works?—There is a tremendous throw-off.

1572. (*Chairman.*) Do you think that throwing a series of groins along the coast to the southward would arrest the travel of the sand?—There are a series of "Public Works" groins along there. Of course, the only effect would be that you would throw this sand out quicker. Then there is the Coom River (which comes down *here*) which interferes with all those arrangements.

1573. (*Sir John Coode.*) General Sankey intimated to us his opinion that the travel of the sand from the south might be arrested by the projection of groins from the shore; do you agree with that?—There are groins there, but they must have a limit.

1574. Do you think the sand travelling in a northerly direction could be arrested by a series of groins along the shore?—In this particular place as you mean?

1575. Yes?—It is arrested now, we say, from some cause or other. There is a large groin at the mouth of the Coom.

1576. You say it is arrested; when was it arrested?—I think I said in my evidence that for a year and a half we have noticed it.

1577. Then your observations only go to that can be seen above water?—Of course. At the mouth of the Coom, there is a groin which they have lengthened lately, to try and keep the Coom mouth open.

1578. How far is that south of Madras?—Two miles south of this wall.

1579. Two miles south of the south breakwater?—Yes.

1580. What have they done there?—They have put the groin out. When strong "freshes" come down, the Coom bursts at the mouth. It is filled up generally by the engineer.

1581. Filled up by the engineers; with what object?—There is a lattice girder bridge across; no one knows why they did it, but it has been done for many years.

1582. There must be some reason?—I suppose the reason is to keep the river in the neighbourhood of the town.

1583. (*Admiral Sir George Nares.*) There are large works going on south of Madras now on the beach, on the foreshore?—Not "works" as you would call them.

1584. Groin works?—No; the groins have been abandoned except *this*. They have lengthened this Coom groin about 150 feet in the last year and a half, but there are the old "Public Works" groins remaining.

1585. In the last year and a half one groin has been lengthened 150 feet?—That is the one at the Coom mouth.

1586. Is that on the south side of the river or the north side?—The south side.

1587. (*Chairman.*) Had that any reference to the harbour works?—None whatever.

1588. (*Sir John Coode.*) Had it any effect upon the harbour works?—None whatever.

1589. (*Admiral Sir George Nares.*) It could not be taken in connexion with your statement that the foreshore had stopped advancing in the last year or so?—When I say "the foreshore" I only mean this corner close to the harbour.

1590. You told us the foreshore had stopped advancing for about a year and a half?—Yes, at the pier.

1591. Without having any connexion with this groin that has been built up?—No, no connexion. There are groins all the way along. There is a groin opposite the lighthouse, and there is a groin further down. The moment the sand silts up beyond these they are inoperative. When a strong gale, or monsoon wind, and sea comes, it cuts away all this sand again, and it goes back to its old place. As I tell you, two years ago, the beach, which you would think now would never be approached by the sea, was cut away, three parts of it. The whole sea face was carried away and the water came very nearly up to the guns on the new battery; *now*, it has all restored itself again without anyone doing anything, and you would think it utterly impossible for the sea to ever come to it.

1592. (*Sir John Coode.*) You spoke this morning of the strong westerly winds off shore, should you apprehend any risk of a vessel being driven against the extension of *this* overlapping arm if the reconstruction were carried out according to the design No. 4?—No apprehension whatever.

1593. You seemed to apprehend that there would be a difficulty about vessels passing through the present entrance; why should not the same thing be done in regard to the north-east entrance, I mean the extension of the harbour on the north-east side, to the extension of the line of the north-east entrance?—Because of the large areas of the bank of sand that is formed in that way by the action of the wind and sea?—How do you get it back. The sea keeps it back.

1594. When once the sand has been deposited there the sea would not be able to get it back?—There would be a risk of their being deposited there, but I do not think it would be to the same extent as it is now, because it is kept by breakwaters. The whole face of the beach there is higher than any of the waves, and the force of the wind would come in a direction which would not be so likely to deposit it there as it is now. You see the waves are coming in a cyclone from the south-east, and they are deposited there by breakwaters. The whole face of the beach there is higher than any of the waves, and the force of the wind would come in a direction which would not be so likely to deposit it there as it is now. You see the waves are coming in a cyclone from the south-east, and they are deposited there by

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communicate with me every day, giving forecasts of the weather. In all cases where storms are coming up *from the southward, we all know of them. In fact, they are generally over before I get the telegrams from Mr. Blanford.*

1598. That I can quite understand?—A telegram comes as quick as anything can do, but he is guided by the opinions of men who collect information for him down here. They are, generally speaking, officials who understand nothing about the weather, and who never look at the sea, and only when the barometer begins to go down, do they give him any notice; whereas, my experience is that the barometer remains higher than usual in front of the advance of a cyclone; and I flatly have been in as many cyclones as any living man.

1599. (*Chairman.*) Was the great storm in 1872 or 1873?—1872.

1600. Were you at Madras then?—I was approaching it at the time.

1601. Was that very much more severe than the 1881 storm that destroyed the breakwater at Madras?—I was not in the strength of the storm. I took care not to be in that position; but from the effects produced, I should say the wind must have been a little stronger. I think the astronomer's estimate was 46 lbs. against 52 lbs. pressure.

1602. Is that once the centre of the storm passed nearer to Madras, did it not, than in the case of the 1881 storm?—Yes; the centre of it passed a little way south of Madras. The wind came from the east. When the centre of the storm passes to the south of Madras the wind veers to the east; and that was the cause of all those ships coming ashore. The heavy swell and the wind together brought them all ashore; and I think there were 30 or 40 vessels, native craft included, wrecked between the Clive battery and the Coom; and it was that that led the then Governor, Lord Hobart, to propose to have a harbour. He thought it would be a harbour of refuge; but when it was projected, and all the expense gone into, Mr. Parkes said it could never be a harbour of refuge. It would never have been commenced but for that storm.

1603. Now, you think that if you can only get an entrance at the north-east it may be a harbour of refuge—for small craft, at any rate?—Small craft could never trouble their heads at all. They have only got to keep steam up.

1604. I mean that you would be able to use larger lighters. The harbour craft generally would be means? —We might use larger; but we have good big ones now.

1605. But they get ashore in a cyclone, do not they? —They always go ashore in a cyclone and break up, and it costs a lot of money repairing them. It is to remedy that that we want the harbour.

1606. Have you taken into consideration any plan for carrying up a fresh harbour to the south-west angle of the mole?—I have not taken that into consideration, however, for the last I do not think it would be practicable. I have heard that Mr. Parkes proposed one at this place, but we could not use this boat harbour by traffic because the whole of this space is occupied by houses, and it would be utterly impossible for us to get there. The centre of trade is between the harbour walls.

1607. But the part that it is proposed to utilize, I think, is the reclaimed ground, in fact, the sand that has been deposited where the harbour works were put up?—Yes, but the surface is sand, but at about 12 to 15 feet from the surface it is rock. I may say that when the sewer was made, and any hole cut there naturally although as any other part of the work, would inevitably give way to the sea when the storm came, and the hole would join together again. The bottom would have to be of concrete also, because the sand and the water flow up and you cannot possibly manage it. I contest that myself in trying to sink a caisson for the tidal gauge down here.

1608. About the central part of the harbour, near the jetty?—Close to the jetty. It was considered better to have a pier from the quay wall further out so as to secure perfectly smooth water in the tide gauge. We get the correct tidings 2 feet wide; I think it was, of 2 feet wide, and, notwithstanding all the public works purposes, and all the divers, and everything we could do, we could not empty that thing. The sand and water kept coming up and coming up, and Mr. Thorowgood had the same difficulty in trying to make a drain or intercepting sewer. He had to borrow every pump in the place, and then could not do it. I do not speak as an engineer, but from what I know of the matter I think it would be imperatively necessary to have a concrete bottom, which would prove to be a very heavy one, and concrete sides to this boat harbour, which would cost an awful lot of money.

1609. In your experience has that stood been knocked up to the houses?—Yes, it has.

1610. Or is it not the case that that ground which has been reclaimed from the sea by the deposit of sand since the harbour works were constructed has been broken up and built upon?—No, there is only a small shed here.

1611. I do not see what is there, but it is being utilized, is it not?—A small portion of it, close up to the wall; and batteries are built there. *Here are the* new batteries. That is not the battery I have been speaking of.

1612. (*Admiral Sir George Nares.*) Would a cyclone wave reach the new battery now, if you had the same wave as you had in 1881?—It would depend upon the current. If a stronger cyclone current came from the north it would certainly cut away all this.

1613. But take the same sea that destroyed the end of the pier in 1881?—That sea did not have much effect upon this. There was not much difference in the storms that the whole of this part was filled.

1614. It did not overrun all that reclaimed land?— It covered all this part of the land. A large tide formed in the middle here; it runs over the bank and of sand and washes to fill it up with sand from the places afterwards.

1615. Did it affect the beach as far up as the mineral cattle stable, as marked on the plan?—Further north than that, opposite the Chief Engineer's Commerce. As I say the current only set about from the wall that the first operation of it is some 100 corner. If there had been a 10-foot, a 20-foot, a 30-foot basin there the sea would have made a complete sweep of the commercial cattle shed.

1616. Then some of the reclaimed land has been used for building now?—We think not, unless you call that a foundation in two feet.

1617. (*Sir John Coode.*) It would require some very strong sea indeed, at any rate?—It would require tremendous pressure.

1618. And it would not be a very probable thing, to use a word, that?—There is no question about it. The fact is that the sand on that coast, and the water, are almost equally mobile. The sand moves about almost like water. It is very very fine sand, and it moves about almost as readily as water. It is not like shingle, and we have lost 200 feet out of 400 feet of the breakwater already, inside.

1619. (*Chairman.*) By what—by drift sand?—By sifting up from the shore, from tidal flow, scouring and the other. What was the lighthouse built about ninety years ago is now 200 and odd feet from the sea; and that is going on very fast.

1620. (*Admiral Sir George Nares.*) Inside the harbour?—Yes.

1621. But you said?—No, by the drift sand from the beach and the tidal flow. There is no intercepting sewer which goes from the length of the harbour, and has sufficient capacity to take, at any height to let, what they call the storm water, which comes into the harbour. They close to sometimes that outlet, and the storm water would go through, instead of the bulk of it as rapidly as possible. It is running to fill up the harbour that the object which Mr. Parkes proposed to remedy. It is necessary to the security of the two finished ships, and as soon as there are available for ships. There is no room there for the big ship now.

1622. Has there been a shoaling up in the inner part of the harbour to that extent?—Yes, some three 200 feet.

1623. The water line may have gone out, but has the water been shoaled outside of the water line to a great extent?—There is no difference in the shoaling now to what you can see.

1624. The line is the same as before?—As far as you can see it, it is.

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boats cannot lie at it. If we had smooth water we should run jetties out over *this* part that is shelving and dredge up between them. The Masoolah boats would not require to beach every night.

1626. To keep the face of your wharves clear you would have to employ dredgers?—Yes, light hand dredgers—little things. You see, a Masoolah boat cannot stay out. She cannot anchor out. If she remains more than a day in the water she gets so soaked that half her value is destroyed, so that they must beach every night. The lighters are not so tender. The lighters remain at anchor. You must have a beach for the Masoolah boats until some effectual means is given of doing away with the Masoolah boats, which can only be by jetties or quays; and with the surf prevailing in the harbour, no boat could ever lie alongside a quay as it is now. Even the Masoolah boats wet half their cargoes in just broaching to.

1627. (*Sir John Coode.*) You feel that it will not be at all a satisfactory state of things until the Masoolah boat can be abolished?—If we were able to use quays, by which the trade could be carried on by lighters along the beach, we should save at once about eight annas or perhaps 12 annas in the rupee, which is now wasted in the boat hire; and that would carry on the construction for many a long day.

1628. And you are quite satisfied that that could be done if you had a north-east entrance instead of an easterly entrance?—Certainly I am.

1629. (*Chairman.*) The cyclones bring about a very considerable increase of the water level, do they not?—Inside the harbour.

1630. Not outside too?—No. What we call a storm wave sometimes comes.

1631. I do not mean a wave only, but a general elevation?—No; we have no means of detecting it. The tide gauges in the port—north and south—do not shew it. The base of the lighthouse is about eight feet.

1632. Have you known that reached by a storm wave?—No, but there is a revetment all along there, which was done by the great De Haviland. All the way from the fort up to the Clive battery there is an enormous revetment. About 60 or 70 years ago the whole face of the town was threatened with destruction by the sea, and De Haviland, who was then the chief engineer, constructed a breakwater that cost 35 lacs, the whole way from there, of large stones of four and five tons weight with a slope 45 feet from the upright part. That saved the town, and protected the whole town. Since that time sand has accumulated, and there has been no further trouble until you come to the De Haviland bulwark. I found this out by accident. When the battery was threatened General Sankey came to me and lamented about the enormous expense it would be to get stone. I was asked to give my opinion about revetting the battery. He said it would cost an enormous lot of money. I said, "You have it all at "hand there; there is the De Haviland bulwark you "can work upon." He said, "I never heard of it." They sent for some men out of the fort; and they came and dug out the place I told him; and there were these enormous stones lying there, and had been for any length of time, unused. *Now* they are employed at that revetment of the Coom in strengthening Mr. Grant Duff's new garden. The joint operation of all these things brings about the silting in the harbour which has lost us the 200 feet of beach in the last two years, at least gained us beach and lost us water.

1633. And that affects the question of building quays?—We cannot do anything until we get smooth water from the outside. It has no effect on the question of quays, because we could build over *this* space and you might put in a coping, or something, to turn away the whole of the drainage system, and protect the sand from coming.

1634. Is the drainage being turned away from the harbour now?—No, they are going to double the capacity of the sewer.

1635. (*Sir John Coode.*) Doubling the sewer to diminish the quantity of sewage; is that the argument?

1637. Then the sewage now, which is discharged does not flow into the harbour, but it is carried such a quantity of that as into operation; is that not so?—Yes, it is carried into the sea by means of deep 6-feet sewers. They go all through the Broadway, in the centre of the town, and turn down by the fort; and they used to open into the sea there.

1638. What we want to know is, simply, to what extent does the sewage get into the harbour, I understand from the answer you gave just now that the main sewers go to the north and south?—To the north and the south is supposed to be stopped up on account of the smell it conveys to the port. They have been obliged to extend it several hundred feet further out, because the intercepting sewer will not carry away the sewage.

1639. That is to the south of the harbour?—That is to the south of the harbour.

1640. Then no sewage comes in except that which is brought in when the storm overflows are acting?—Yes.

1641. Do you find any quantity of foul sewage come into the harbour on those occasions?—The whole beach smells so badly that you cannot tell which is which. Each house has its complaint to make of smells, but whether the smells come from the harbour or from an open drain you cannot tell.

1642. (*Admiral Sir George Nares.*) I understand that the estimated cost of the harbour, if completed according to the present designs, will be 46 lacs of rupees?—I believe so. It is so stated in the Act.

1643. But the Harbour Board are prepared if they can get quiet water to borrow to the extent of 200,000*l.* more probably?—I cannot deal with sums. They are prepared to get what they want at whatever price.

1644. But as a member of the Harbour Board you have agreed to the proposals that are put before us now, in which the estimated cost of the works has been increased about 200,000*l.*?—Well, to speak the truth, these estimates I never read until I got them here in London, they were only finished and sent in by Mr. Thorowgood the evening I left; but I have no objection to take them as approximate.

1645. Can you tell us, about, the foot run of foundation that will have to be removed for this last proposal of the Harbour Trust?—No.

1646. You have not entered into that?—We cannot do it until we know exactly what points are selected.

1647. But the plan has passed your board and been thoroughly considered, I suppose?—Yes, it has been thoroughly considered.

1648. But you cannot give us the foot run?—No, we did not enter upon that.

1649. We must measure it for ourselves?—Mr. Thorowgood is our engineer; he is the man who supplies us with that.

1650. But, of the adopted plans now put before us, I have to measure for myself what length of work will have to be removed to open the mouth of the harbour at the north-east end, that is to say, to judge for myself, and form my own opinion; I cannot take it from you, I must measure the plans?—Or telegraph for the information if you want it. I cannot give it. I do not believe my estimate agrees with the "completion certificate."

1651. You want to close the east entrance because the harbour has to be protected from the easterly ground swell?—Yes.

1652. With the north-east monsoon (which we have been informed is the strongest monsoon) will it be necessary to protect the harbour from any seas coming from the north-east?—Yes, by extending the north sea wall.

1653. And if the line from the end of the north jetty to the end of your easterly extension work bears north-east, will that protect the harbour from the sea during the north-east monsoon?—Much less than that. I consider the angle to be about 22 degrees.

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1654. Say any sea that you care about keeping out of the harbour?—Any that we have seen for any number of years. On the last occasion the sea simply ran along the area without any protection from the north-east whatever.

1655. At present with an easterly entrance and the two breakwaters forming a right angle to the heaviest sea, there is a minimum disturbance in the entrance to a vessel entering, is there not?—I am not quite clear that I understand the question.

1656. A steamer entering between two piers that are at right angles to the heaviest sea would face the water in the entrance with less disturbance to affect her steering, than with breakwaters in any other direction?—No, I do not agree with that at all. The current is the thing which disturbs the ship's entrance, as well as the swell.

1657. Is there any current now at the eastern entrance to affect shipping entering the harbour?—We have never had any difficulty with the ships entering or going out, except in bad weather, and then they cannot get out. Two ships have tried it, and they very nearly came to grief. They could have got out with the north opening easily enough because they would have had their heads to the wind, and could have got full steam on, but they could not with the eastern opening because with that they would be on the wall before they knew where they were. They could not get steerage way.

1658. Would not a vessel, passing the end of a breakwater going with the course of the sea, be less affected than one steering at an angle up to the breakwater and meeting the same sea on the quarter, or the beam?—I do not really exactly follow you.

1659. I will put it in another way. Would an entrance through which a ship has to pass, with the sea directly astern of her, have to be broader or narrower than an entrance which a vessel has to pass through with the sea on her beam, or on her quarter. It is a question of the case of the navigation of the ship, and the effect of the sea on her quarter in entering, or on her bow in leaving?—I believe they would be equally navigable, unless in the case of very bad weather.

1660. And in very bad weather, which ought to be the broadest opening?—In bad weather they could not come in at all, in Madras.

1661. Say the worst weather in which they could come in. I am not talking of Madras now. I am talking about the question of navigation irrespective of Madras?—It must depend upon so many matters inside the place, and outside, that I really do not see how I could give you an answer. It is with Madras that we are dealing.

1662. Then we had better ask the pilot I suppose, who has been accustomed to take vessels in?—You say irrespective of Madras.

1663. Irrespective of Madras.—He has never been accustomed to any other place than Madras.

1664. A pilot who has been accustomed to handle these 500-foot ships will be able to tell us?—Only in Madras.

1665. And anywhere else?—He has never been a pilot anywhere else.

1666. Can you tell us, as a seaman, which you would like to enter?—I would rather come into a place like Madras where I had got deeper water, with the wind aft.

1667. Then the opening should be wider if the vessel has to meet with a beam sea than if she has to meet with a head sea or stern sea, the same breadth of opening would not do for both, one will have to be wider, and I want to know which it is?—I do not know why the one should be wider than the other.

1668. You know there is a greater difficulty with the one than with the other?—The question of the width is settled within a few feet. The pilot will tell you probably that he is obliged to angle his ship going out at that eastern opening, whereas he would go straight out with a northerly one.

1669. On what course?—A north course, until he gets past the protecting arm. Then the ship would take her course.

1670. And on that north course you tell us he would be sure to have a beam sea within two points?—Just for a moment while she was answering her helm. At present, I think he would tell you, that ships that have just got outside the harbour have had the sea come over them before they had time to know where they were, and before they could turn round north or south. The best opinion I can give is that there is no difficulty in either entrance.

1671. In what monsoon would they have the sea come over them?—In the northern monsoon.

1672. Irrespective of a cyclone or of the very heavy sea in a cyclone?—No, not a very heavy sea by any means; not sufficient to embarrass a ship at all.

1673. Still, just to come on the deck of the ship?—I think the pilot mentioned once that the sea came on board just as they got outside.

1674. Could a vessel be moved in at the eastern entrance as it was when the harbour was complete with a following sea?—With a following sea.

1675. In the north-east monsoon?—She could be towed in. I have no doubt she would have to cast anchor almost immediately, because there would not be room enough for the tug and the ship.

1676. We should have to consider the size of the harbour then?—Yes; you cannot utilise the deep-water space, because if the ship is going north or south she cuts into deep-water space.

1677. If the vessel has to go north going out of the proposed north-east entrance how far will you be able to use the deep-water space so as to let her head for the entrance?—All the way up the coast?

1678. No, I mean inside the harbour. You see, she has to point her head north to go out of the north-east entrance?—Yes.

1679. What space will you have to keep clear of other ships?—When you come in from the north do you mean?

1680. Yes: the harbour being 3,000 feet, remember?—If we fill up the southern side with ships, as we hope to do, and to have them all in, she would have no more than if she came in from the east now, when there are only seven ships.

1681. You have not answered my question?—A vessel, you told us, has to point north going out, and south coming in at the north-east entrance. Now, she will have to turn into the harbour or turn out of the harbour. What space will you have to keep clear of vessels in the 3,000 feet along the eastern face to give room for vessels coming in and going out?—I do not suppose it would be any more along the eastern one. It is the southern one we expect to be able to utilise.

1682. Then the whole of that deep-water space will have to be left for vessels coming in and going out?—No; it is a question you cannot answer, because it must depend upon circumstances. There may be one vessel a little more or a little less in the way in coming into a narrow pond like that. You cannot exactly say what the circumstances may be.

1683. But you would not have to keep the whole of the space clear?—Certainly not. One of the objects of getting the northern entrance is to use the deep water which we cannot use now so far as ships go.

1684. Do you expect to bring sailing ships in when the north-east entrance is completed?—If there are any left. They are fast dying out. The only sailing ships that come now are emigrant ships.

1685. Do not you apprehend a difficulty in towing them in and towing them out with a beam sea in the north-east monsoon?—With a beam sea? I do not quite understand. With a northern entrance they would be outside the harbour before they felt the beam sea.

1686. But taking the yawing of a ship coming in, rounding the north end of the eastern face, do you think a tug could tow a ship in with the heavy sea that you told us is experienced in a north-east monsoon?—I did not tell you "a heavy sea." I contradicted it directly it was suggested.

1687. The sea that at the entrance has been known to come on the deck of a ship?—On one occasion I said the pilot spoke of the spray—on the sea—having come over the deck of the ship. We do not turn round *there*, as you describe. By the order of the Government each ship is obliged to make a circuit, so as to come in from a comparative distance. It was found necessary to pass a rule of that kind.

1688. For what distance?—That was said to be half a mile, because it appeared to ships coming in from a distance that sailing ships were moored across the mouth of the harbour; but when they came opposite to them they saw that a way was religiously kept clear for them to come in. A tug would tow a steamer in long before there would be any occasion to yaw.

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1689. We have been told by the captains of some of those large ships we have spoken about, that they would not like to expose their vessels to a beam sea entering with that north-east entrance and with the surf breaking only about 500 or 600 feet to leeward of them. What do you think of it?—But it is a condition that does not exist.

1690. Then how far would the surf be breaking to leeward of them?—A quarter of a mile.

1691. Our chart gives us only 3,000 feet as the whole length of the harbour?—Well, 3,000 feet.

1692. Where does the surf break in the north-east monsoon—at what depth of water—outside the harbour, four or five fathoms?—Oh, dear no; one, two, or three, generally, unless it is very bad weather, and then they break further out.

1693. But we have had evidence here to the effect that in all ordinary north-east monsoons it does break at about four or four and a half fathoms?—It does not do anything of the kind.

1694. You do not agree to that?—No.

1695. What do you say it breaks at?—Well, I should say, at the very outside, 300 or 400 feet.

1696. Then you think we need not consider that, although captains of large steamers have given it in evidence?—I do not know who the captains are. They have probably given the evidence for a totally different purpose.

1697. I am not questioning about who they are; but my question is, that you do not think we need consider it?—I am certain you need not consider it. If they have been commanders who have been to Madras, they have all given evidence in favour of the north-east opening; and if they are others who have not been there, I do not value their evidence as being worth the paper it was written upon.

1698. We have also had evidence that in the case of those large steamers there is more liability, not to an accident, but to some stoppage being required for a moment or two down in the engine-room just when they are starting than at any other time of the voyage, and that if there was a north-east entrance and the engineer wanted to stop, with this beam sea, he could not?—He must be outside the entrance before he could feel the beam sea.

1699. I presume that when outside the entrance (say just outside the entrance), with a beam sea, they would not like to expose their vessels in that position with the engines stopped; do you think there was anything in that evidence?—Nothing at all. A sailor would put his anchor down at once, and wait until the bell sounded that the engine-room was ready. He would just drop the anchor if he felt any inconvenience at all, inside or outside.

1700. Does much of the trade approaching Madras come from the direction of Calcutta in these large steamers that we are talking about?—Both ways. Steamers come from Colombo; they unload a portion of their cargo at Colombo, come up to Madras, and unload a portion there, then go on to Calcutta and finish their loading. In returning home they perform pretty much the same operation.

1701. Then the course of a vessel from Madras to Calcutta would be about north-east, would it not?—The course, after she is clear of the harbour, would be about north-east.

1702. And would that be with the sea on the bow or the beam?—Exactly the same as if they were going out at the eastern opening. It would make no difference. The moment they were clear of the opening they would shift their course and do what they pleased.

1703. Then, as regards any evidence that we have already received from captains of ships in connexion with an eastern entrance, we may conclude that their vessel has to meet the sea on a north-east course, whether the entrance is on the east side or on the north-east side?—Certainly, if they are going north.

1704. And if they are bound south, that they will then be practically beam on to the sea for a considerable time before they approach the harbour or after they leave it?—The only question connected with the harbour is the moment when the ship is just changing from the smooth water: she gets to rough water the moment she gets outside with a free course; it is the same whether she goes to Calcutta or elsewhere, she shifts her course immediately. We have nothing to do with it.

1705. That is, beam on to the sea, when bound south?—A man need not go beam on to the sea, he can go a little to the east. It is a question of seamanship that falls on the captain. It is the harbour-master we deal with. The moment the harbour-master has got the ship outside the harbour the captain can choose what course he likes. The harbour-master's difficulty is just that of getting them out at one opening or the other. I have sat in my office looking on for 13 years, and I think I have seen nearly all the ships that have come in and gone out, and I have never seen one that required to alter her course or to accommodate herself to the sea yet.

1706. Are we to understand from you that moorings were ever laid down in this harbour?—Yes.

1707. How many sets; can you remember?—I think it was six. It was in that operation of the wall falling down that the screw moorings were lost, and after that nothing more was done.

1708. Were those in use for any length of time?—No, they were never in use. In fact they are so near the shore now that we can only use them for stern moorings.

1709. In consequence of silting up?—Yes.

1710. (*Sir John Coode.*) How many sets were put down?—I will not trust my memory, but I think it will be found in some of *those* papers. I need hardly say that if you cover a small space like *this* with bridle moorings, or screw moorings of immense strength, and a ship for a good cause (to avoid a collision or anything else) is obliged to let go her anchor, she must hook one of those and then there she is. She must lose her anchor, or at any rate, waste a great deal of time.

1711. (*Chairman.*) Then you do not approve of the system of having moorings?—If we have smooth water, I do. If we have smooth water so that the chain can not fret and chafe on the bottom, just on the sand, I have no objection whatever—in fact, I have got buoys myself at the entrance, but I change them every six months, and I find then that the cables are nearly all worn through in the six months.

1712. These are warping buoys that you speak of, are they not?—Just to mark the entrance to the harbour. The moorings that we now use are stern moorings and are single screws. Ships walk off with them. At present they anchor by the ship's own chains and make fast to the buoys that are left.

1713. (*Admiral Sir George Nares.*) What objection is there to plan No. 4, the red one?—It brings the ships into the middle of the harbour again.

1714. Brings what ships?—Any ship coming *here* seeking a berth would have to go down *there* or down *there*, and deprive us of the deep-water space. We might have a line of ships moored in *here*. The walls would be strong enough to have bollards to make the lines fast to. There are two classes of steamers, one with full cargoes requiring days to discharge, and others only landing passengers and small cargoes. At present the berths are taken by turns, and owing to want of space much delay is often caused to shipping requiring dispatch.

1715. (*Sir John Coode.*) Then you do not approve of No. 4 plan?—No, I do not. Though it looks as though it gave the same shelter as No. 3, it is very far from doing it. The sea would come against *this*.

1716. That is to say the sea would come against the seaward portion of the northern arm?—Yes.

1717. Which plan do you prefer?—"C.," the yellow one, No. 3.

1718. (*Admiral Sir George Nares.*) You are speaking now as regards the commercial facilities inside the harbour, and not as regards the entering it, or leaving it, of the ships?—No; I do not think there is any importance to be attached to that whatever. I think there would be no difficulty in getting the ships in and out, whether the opening was *there* or *here*; but as respects the space employed for the ships, and as

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affects the shore, unless we get smooth water, I consider the harbour will never be worth having. It is very true that *this* may appear to be the same distance, but it is a very different thing. Even if the wind is north-east say, a good deal of wild will come in *there*, but if the sea is north-east it will only run along as it does now.

1719. In plan No. 4, suppose the eastern face was prolonged until it bore the same from the other pier as in No. 3 plan, what would you think of it then,—that is to say, if it bore north-east,—which is the same direction as the pier heads bear one from the other in No. 3 plan, and therefore it would afford the same shelter inside the harbour?—It would be useless expense, because you would get the same amount of protection. All this (*pointing*) old work has to be taken up besides, in the red plan; that (*pointing*) is all old broken concrete blocks.

1720. If the captains of the steamers have an objection to pointing their ships north going out, ought not we to consider their objection?—If the objection is founded on reason.

1721. If they all agree?—They do not. Every man who has been to Madras has given his opinion in favour of a north-east entrance. What their motive for changing when they come here may be, I do not know.

1722. You think we ought not to listen to them?—Of course I cannot answer for you, gentlemen, but I should not myself, I think.

1723. (*Sir John Coode.*) Which opinion would you take, the one they gave in Madras or the one they gave here?—The experience gained on the spot.

1724. But when they come here, their experience has still been gained on the spot?—And it is recorded here (*referring to a document*). When they come *here* they change their opinion for some reason; I do not know what.

1725. May it be that they have further considered the matter?—Mr. Thorowgood changed his opinion right round the moment he came ashore. We do not gain the same water space as we should on the opening N.E. Without the deep-water space it would be a wretched little place, and without smooth water it would not be good for commercial purposes.

1726. (*Admiral Sir George Nares.*) But surely with No. 4 plan you gain a large amount of water space under the north pier, do you not?—You cannot go very near it, and you come on the rubble base before you come near the wall.

1727. But after the harbour is completed and the water quiet, vessels will be able to come near up, will they not?—The harbour will not be quiet so long as there is an opening east.

1728. I am supposing the pier heads to bear north-east from one another, which is in the same direction as No. 3 plan?—That would involve a terrible additional expense.

1729. Then we have not only to consider the question of a quiet harbour, but the question of expense?—All *this* is extra work. All this (*pointing*) got to be taken up just the same as in No. 3.

1730. But would you not have as much deep-water space for mooring your vessels with No. 4 plan as with No. 3?—No.

1731. Why not?—Because we have the whole space *there*. At present the harbour may be said to be cut in half; *that* part is inaccessible for large ships; *this* part is the part in use. Ships have to come in *here*, and have to seek their berths *here*, or *here*. The consequence is that we cannot use either *this* corner, or *this* corner, except in the case of a very small steamer coming in. If they came in from *here* we should have *that* space clear, and that half also for ships that wanted to stay eight or ten days, loaded with iron or anything of that kind.

1732. I cannot follow you there, because so far as I can measure I think you would have as much deep-water space on the design of No. 4 plan as with that of the No. 3 plan?—Of course that is a matter of opinion.

1733. (*Chairman.*) Can you give us an idea of the requirements of the harbour. Have you ever been obliged to keep vessels outside because there was not room for them inside?—Yes, very often.

1734. If you had still water, and moorings laid down, you would be able to accommodate more ships?—You would be able to accommodate more ships, besides, if you have moorings down, in smooth water you can warp ships about. You can do 50 things with them that you cannot do now, when there is a wobble on.

Adjourned to Friday next at 11.30.

At the Board of Trade, Whitehall.

Friday, 10th June 1887.

MEMBERS PRESENT:

VICE-ADMIRAL SIR NOWELL SALMON, V.C., K.C.B., IN THE CHAIR.

SIR JOHN COODE, K.C.M.G.

REAR-ADMIRAL SIR GEORGE S. NARES, K.C.B.
MR. F. C. THOMPSON [India Office], *Secretary*.

Mr. WILLIAM HENRY HORNE examined.

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1735. (*Chairman.*) Will you state to the Committee the nature of the appointment which you hold?—I was formerly the harbour-master, from 1881 to 1886. I am now called the Senior Government Port Pilot at Madras.

1736. From whom do you hold this appointment?—I was appointed by Captain Taylor, and confirmed in my appointment by the Government.

1737. Do you mean under the Madras Government?—No, the Supreme Government at Simla. The Harbour Trust want me for their work, but our people do not agree to it.

1738. (*Sir John Coode.*) Therefore you are not a Harbour Trust officer at present?—No, I belong to the Supreme Government; Captain Taylor is the vice-president of the Harbour Trust.

1739. Still his appointment is directly from the Government?—Yes.

1740. He does not hold office under the Harbour Trust?—No.

1741. (*Chairman.*) How long have you held this appointment?—Six years, the 8th of last March.

1742. During which time you have been constantly in the habit of piloting vessels in and out of the harbour?—Yes; and I have also had charge of all the moorings, besides all the anchors, chains, buoys, and boats, &c.

1743. As pilot of course you are constantly acquainting yourself with any changes in the soundings?—Yes.

1744. Have you noticed any changes in the soundings in the present entrance?—Not at all in the entrance.

1745. Or any changes taking place inside the harbour?—A little at the south-west corner, it seems to make up a little there.

1746. Could you give us an idea to what extent?—Within six years I should think it has made about two feet. My first soundings when I first came and took charge of the port would be about 15 feet, and now there is 13 feet where there used to be 15 feet. That is in the south-west corner, south of the pier.

1747. What advance has there been in that shore line inside the harbour?—Very little.

1748. Where does that small amount of silt come from, does it come through the entrance do you think, or is it blown sand?—I think it is blown sand, and sand that has washed through the crevices in the south arm

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from the long continuation for nine months of the southerly current.

1749. Outside the harbour to the south, we have it in evidence already that the advance there has been very considerable, but that for the last two years it has been proportionately smaller, do you confirm that?—Yes, that has been so.

1750. Have you taken any steps to ascertain whether the soundings are decreasing rapidly?—No; I have taken my soundings outside there, and I find that the tendency has been steadily to increase and not to decrease, but for the last two years, as you say, there has been little or no amount of increase, although in the first three or four years of my office there it came up immensely.

1751. We have also heard that the sand has commenced to deposit at the south-east corner and form a bank there outside the harbour. Are you aware of that?—No, I have not made soundings out there during the last six months, as I think it is unnecessary, as different ships would be anchored there, and they have always found water equal to 8½ fathoms there.

1752. I mean inside there, just close to the knuckle?—Vessels do not anchor there; and I have not sounded along there.

1753. Supposing there to be any changes in the soundings, do you make any notes of them?—Yes; I keep a diary.

1754. And do you transfer them to any chart that you have?—No; I have not done so. I make my own chart of the south harbour all round the inside of it, and I form a plan of my own, and then I put down my own soundings.

1755. Have you that plan with you?—No, I left them all behind me. I was not aware that I should require those things; and I left my diary and all my soundings behind.

1756. Could you by looking at this chart tell us whether that is in accordance with the present state of the soundings (*handing chart to the witness*)?—We have not got eight fathoms at the entrance at that end of the pier. We have only got 19 feet instead of 3½ fathoms as is marked on the chart. We have only got 19 feet instead of 21 feet at the end of the pier, and 15 feet at the steps.

1757. (*Admiral Sir George Nares.*) What means have you of fixing the position of your soundings outside the harbour?—By the bearings. I take the Madras Railway Station for one bearing, and I take Parry's flagstaff as another bearing.

1758. Do you do it by compass?—No; just by getting the two figures in a line, just having them a certain distance off from the wall; and then I strike from there and go straight along from the point of bearing to the wall.

1759. Then you do not use sextant angles?—No.

1760. (*Sir John Coode.*) Do you watch the range of the tide by a gauge and make the necessary allowance?—We have our tide tables, and from that I deduct or increase. I always try to get a low bottom at a full, and change once a fortnight.

1761. All from your own soundings?—Yes.

1762. And do you then refer them to the tide table?—Yes.

1763. (*Admiral Sir George Nares.*) What send of the sea do you find in the finest weather of the southern monsoon, when you are taking soundings? How do you allow for the send of the sea in your boat?—I select smooth water, when it is like a mill pond.

1764. Then you can obtain soundings at Madras, can you, in smooth water?—Yes.

1765. Where there could practically be no error in the depth obtained?—Precisely so, it is as smooth as this table.

1766. (*Sir John Coode.*) How frequently would that occur?—A good deal of the year round.

1767. Would you have anything like an average of a day or two in the course of a week?—Yes, about that.

1768. You speak confidently upon that point?—I speak confidently. Even forty-eight hours after a cyclone it is quite smooth for a few days.

1769. (*Admiral Sir George Nares.*) Then if we wished to have a very accurate survey made of the area round the harbour there is no difficulty whatever in obtaining the depth to within a foot?—I do not see that there is any difficulty at all; of course we have to watch our opportunity.

1770. (*Chairman.*) I think we should like you, from what you say, to give us some evidence about the weather at Madras. Would you expect to find such fine weather and smooth water during the north-east monsoon?—No, not at all.

1771. During the north-east monsoon is the easterly swell, that we have heard so much about, constantly running in?—Yes, very strongly.

1772. Is that a steady wind or is it a squally wind?—The north-east monsoon is a squally wind. We generally get our cyclones running from north-west to south-east. The monsoon is a long-shore wind and very fresh.

1773. And squally?—No, not very squally. It is very strong about noon, and then it tapers away towards evening.

1774. Does it bring a sea with it?—It does bring a little sea and a cross sea.

1775. Does it alter the direction of the swell to any extent?—Yes, it does alter it a little, not much. The swell at that time is east-north-east.

1776. You were speaking about the cyclone weather: do you experience cyclone weather frequently during the north-east monsoon?—Yes, that is our worst time.

1777. Could you give the Committee any idea of how often you would expect to find the north-east monsoon would be affected by what we may call cyclone weather more or less?—Generally before the cyclone breaks the wind veers to the northward.

1778. I do not mean in what direction, but how often it would be affected?—About twice or thrice in the month of November in particular.

1779. For how long a time?—Just for two or three days each time.

1780. Near to the burst of the monsoon?—The burst of the monsoon is in October; and at any time between the month of October and December we may expect cyclones.

1781. (*Chairman.*) So that that is the worst time of the year for harbour work?—Yes, then the current is very strong.

1782. During the south-west monsoon the run of the sea, I believe, is from the south-east?—Yes, and it rolls to the north-west.

1783. Have you often bad weather during the south-east monsoon?—Very squally; and from the north-west for four months it blows a good hurricane for 10 or 15 minutes at a time.

1784. (*Admiral Sir George Nares.*) During the southerly monsoon?—Yes.

1785. At the commencement of it or in the middle?—At the commencement; last year we had it in March. When I left this time we had only had one squall, but we generally depend upon July, June, and August as being the very worst time for north-west squalls.

1786. (*Chairman.*) That is the cyclone weather, I suppose?—No, that has no connexion with the cyclones at all, it is off the land.

1787. During what is called the south-west monsoon you have a steady land and sea breeze?—Yes, a steady land and sea breeze as a rule.

1788. But this is interfered with by those squalls and by bad weather; how often does that occur?—Twice a week throughout the monsoon.

1789. Do those squalls constitute any danger to vessels lying in the harbour?—They are obliged to slack all the moorings; they have to cast off the stern moorings and then ride by the chains.

1790. (*Admiral Sir George Nares.*) Is that in consequence of the sea or in consequence of the wind?—In consequence of the wind; the wind is off the land, there is no sea.

1791. (*Sir John Coode.*) You say that it blows a hurricane for 15 minutes; but before and after those 15 minutes does it continue to blow a strong wind for any length of time?—No, it is a long-shore wind of moderate strength fading away at about 6 or 7 o'clock in the evening when a cloud rises, and the rain comes first and then this sharp severe squall immediately after the rain.

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1792. Does it come in any particular part of the 24 hours?—In the evening it comes at 4 o'clock, that is my knowledge of it, and at 2 o'clock in the morning, if the wind dies away about noon, you get a squall between 4 and 5; and if the wind continues fresh till 6 or 7 o'clock in the evening you get a squall at 2 o'clock in the morning.

1793. Irrespective of squalls, what we would like to know is how long the wind would be blowing with any very great strength?—There is no trace of the wind during the day before that. The squall is brought on by the heat, and it clears away the atmosphere afterwards.

1794. Is there any sign of its approach visible in the sky?—Yes, we always know it is coming if we see the clouds to the north-west and the lightning running along the edge of the clouds.

1795. For any length of time before the violence of the squall comes on?—Yes, until it bursts.

1796. For about how long?—An hour or two hours.

1797. Then there is always something like an hour's notice?—Yes.

1798. And a vessel if she was attempting to enter the harbour is not likely to be caught suddenly, any man acquainted with the locality would see the signs in the sky?—Yes, I always go afloat myself in the evening and inform all the chief officers or the commanders, as the case may be, to look out for squalls. I generally look to that myself.

1799. (*Chairman.*) Supposing a ship to come off the harbour on an evening when you saw one of those cyclones coming, would you bring her in or leave her outside?—I should leave her outside; it would be dangerous to bring her inside.

1800. I suppose that captains would put pressure upon you sometimes to take them in?—Yes, very often; and they have reported me once or twice for not doing so.

1801. (*Admiral Sir George Nares.*) Those squalls are more than the ordinary land wind?—Yes, I have seen the awnings and stanchions all blown up in the air.

1802. For how many weeks would that state of things last?—Through June, July, and August we can always depend upon having those squalls.

1803. About twice a week?—Yes, about that in June, July, and August.

1804. (*Chairman.*) You say that during the north-east monsoons the current is very strong?—Yes, very strong, especially before a cyclone is coming on. I always know when a cyclone is coming, because the current comes first, and the sea comes next, and then the wind.

1805. What direction does the current take?—It takes a southerly direction, a little inclined to the westward; about south-south-west.

1806. And generally speaking along shore?—Yes, along shore usually.

1807. Is it considered that that is affected by the tide?—The tide has an influence, more especially on the ebb tide. The ebb tide sets south, and the flood tide sets north.

1808. Does the flood tide check it at all?—Yes, it does a little.

1809. Do you feel any current during the south-west monsoon?—Yes, about a knot or a knot and a half an hour; but that is very variable. It sets off the land sometimes, and it sets right straight on shore almost at other times.

1810. Is that influenced by the typhoon weather also?—That I could not give any answer to. I think it is influenced by the current outside in the bay and by the winds in the bay during the south-west monsoon.

1811. You do not look for a strong current with the south-west monsoon as you do with the north-east monsoon?—No.

1812. (*Sir John Coode.*) You have not stated what is your idea of the strength of the current in the north-east monsoon?—About three knots an hour.

1813. (*Chairman.*) How do you measure it?—By the log from the ship's stern with a long glass, a 28-second glass. I have done so simply out of curiosity.

1814. Is that about the strongest current that you have known?—When a cyclone is coming I have seen as much as five knots an hour just a day before the cyclone comes on.

1815. (*Sir John Coode.*) Three knots is not an uncommon occurrence, is it?—No, not at all an uncommon occurrence during the north-east monsoon. It only comes just before the wind, and it will last from about 12 hours to 24 hours at the most; but we have always had a current of a knot and a half—that is the minimum throughout.

1816. (*Chairman.*) And always in the direction of the north-east monsoon?—Yes, always north.

1817. During the south-west monsoon you have not such a constant current?—No, it varies very much indeed.

1818. (*Sir John Coode.*) Then we may say the current is not less than a knot and a half?—Yes, not less than a knot and a half.

1819. (*Chairman.*) What system have you of giving warning of approaching bad weather?—Telegraphic information up and down the coast and from Paumben Pass.

1820. That is from where you derive the information; but what system have you of giving information?—Signals. Before we hoist signals to alarm anybody we generally send off information, by circulars, to the different commanders to get steam ready as the weather is looking rather suspicious, and then afterwards if we find it necessary we hoist up signals by day, and lights by night.

1821. I suppose from your experience you can even without telegraphic information, generally form a very fair idea of when a cyclone may be expected?—Yes, we can do so.

1822. Putting your telegraphic information out of consideration, about what amount of warning does the weather give to you?—At least 12 hours in the month of November, but in the month of May it does not give more than about three hours.

1823. Then in the month of November you can depend upon having time enough to get your ships to sea?—Yes.

1824. But not in the month of May?—No, not in the month of May.

1825. Not even with the assistance of the telegraph?—You cannot depend upon it, because you get such cyclones as we had last May without warning.

1826. (*Admiral Sir George Nares.*) And that cyclone was not telegraphed from any other port?—No. I had five ships in the harbour, and had just got them out in time; and when I came back to the pier they could not receive me, and I had to get on a rope's end and crawl up to the pier, and the men were left in the boat to take their own chance.

1827. (*Sir John Coode.*) Do you mean at the pier inside the harbour?—Yes; the sea was running over the jetty at the end of the pier, that is 15 feet above high water.

1828. Did you notice at that time whether the débris of the old work along the seaward face had any effect in breaking up the sea; do you think that the remains of the old work diminished the force of the sea in the harbour at all?—Yes, it did certainly on the west breaking inside the harbour. Our sea breaks in 4 fathoms of water.

1829. Does it break frequently in 8½ fathoms of water?—It does in storms and cyclones always outside the harbour.

1830. How frequently would it break in seven fathoms of water, do you think; how many days during the year?—Only when there are strong winds or cyclones.

1831. But in monsoon times, with a strong wind, where does it break?—Then it breaks in four fathoms in ordinary weather.

1832. How often do you think it would break in five fathoms—that is to say, about half-way from the end of the pier—would you see it often break as far out as that?—Yes.

1833. How many days do you think in the course of the year?—A good deal depends upon the current with regard to that.

1834. Taking an average year, about how many days in the year do you think that the sea breaks as far out as five fathoms?—With the north-east monsoon I should think it would break as five fathoms two days a week at least.

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1835. (*Chairman.*) Is that only on the north side of the harbour or on both sides?—On the north side only.

1836. (*Admiral Sir George Nares.*) Are you speaking from actual measurement, or is it merely your supposition?—I have seen it break at five fathoms about two-thirds outside on the north wall.

1837. (*Sir John Coode.*) That is two-thirds of the distance from the shore to the outer end?—Yes, I always drop the anchors of vessels in 5½ fathoms.

1838. Do you anchor them as far out as 5½ fathoms?—Yes, the reason for that is on account of the Madras Railway, who have all the materials landed on the north side, and they wish to have the vessel as close in shore as possible.

1839. That is the general practice, is it?—Yes.

1840. (*Chairman.*) Even during the north-east monsoon?—No, we cannot go outside then, they have to come inside then.

1841. (*Sir John Coode.*) Do they anchor as far out on any occasion as the outer part of the knuckle of the north pier in the south-west monsoon?—Yes.

1842. In the north-east monsoon I understand that they do not anchor to the northward at all?—No, they do not.

1843. In the south-west monsoon do they anchor as far out as the line of the old pier?—Yes, all the country craft do so.

1844. Supposing an entrance were made to the northward, keeping the passage clear for ships, would you entirely leave this anchorage ground?—No.

1845. You would simply go a little more to the north?—Yes, just a little more to the north.

1846. (*Admiral Sir George Nares.*) You say that the sea breaks in about five fathoms; can you give us any idea where the wave begins to curl before breaking, how much further out?—Almost at the knuckle.

1847. The wave has commenced to be disturbed there?—Yes; but occasionally you will see the wave will break further out than that again in a cyclone.

1848. But in the north-east monsoon where would it break?—In the north-east monsoon it breaks in about five fathoms.

1849. But the wave is disturbed nearly out at the knuckle?—No, not in a regular monsoon, only in a cyclone. In ordinary weather the wave only breaks about two-thirds out on the north side in the north-east monsoon.

1850. And outside that is navigable water?—Yes.

1851. The wave is not effective enough to interfere with the navigation?—No; it is more of a rolling wave there; it does not break.

1852. (*Chairman.*) On the occasion you were speaking of just now, which was last year, did you get all the ships to sea, out of the harbour?—Yes, I got them all out of the harbour. The cyclone commenced at 8 o'clock in the morning. At half-past 6 it was a lovely morning, quite calm, there was a heavy bank of cloud to the southward with lightning running along the edge of it, and at 8 o'clock the Conservator, Captain Marshall, came down and immediately ordered me to take the ships out of the harbour, but before this I had already made arrangements; I had some idea that we were going to get bad weather, and I sent off circulars to two steamers to get their steam up. We managed fortunately to take them out of the harbour, and by half-past 11 we had the harbour clear, and about 1 o'clock the cyclone burst upon us.

1853. Were there any ships lying in the roads at that time?—Yes, they went out into the roads and anchored in 10 fathoms with about 100 fathoms of chain.

1854. Did they ride out the cyclone there?—No, they waited for almost half an hour or an hour to see what would happen, and then they stood away to sea and slipped their anchors.

1855. Did any ship ride out the cyclone in the roadstead?—No.

1856. Do you think any ship could have ridden it out there?—There were two barques that rode it out there; they had two anchors and chains, but all their chain was given out, and with tackles on their cables.

1857. Were they outside the break?—Outside the south-east knuckle. The wind was from the eastward, and they could not get away.

1858. Were they outside the break of the sea?—Just outside, in nine fathoms.

1859. Have you ever seen it break so far out as where those ships were at anchor?—No; I have seen it break in eight fathoms, not in nine fathoms.

1860. Have you ever felt any hesitation as to taking one of those long steamers into the harbour on account of the current?—Yes; I almost came to grief once. The "Bhandara," a hired troopship, was just making the harbour; in the harbour we had six steamers but, we found the current setting strong to the southward and the flags were up to bring her in immediately on account of the troops being waiting on the beach. I told the captain to be very careful and keep the engines steady as there was a strong current passing by. She was about 345 feet long. I thought that I could manage it, and so I steered for the north buoy at the entrance, and just as I got within half my length inside the current was so effective outside that it just turned me completely round, and my stern only just cleared the south groin at the end of the breakwater, so that I had to run out the anchor.

1861. When was this?—This was last November twelve months, when they were sending the troops away for the Burmese Expedition at the time of the north-east monsoon.

1862. And when the harbour works were in their present state?—Yes, in their present state.

1863. You say that the current slewed the ship round?—Yes, right round. I had to go out again and stop there until the current had lost part of its force.

1864. The current slewed you round with your head to the northward?—Yes, to the north-east.

1865. Where was the berth that you proposed to take the ship to?—Right off the pier; my head was here (*pointing to the chart*), I had to go outside and anchor and then come in again.

1866. The ships that were then in the harbour were berthed in the lee of the northern arm, I presume?—Yes, there were two or three vessels berthed there.

1867. The vessels in the harbour were berthed all over the harbour and not on one side only?—Yes, all over the harbour and not on one side only. There was only one berth available, and that was off the pier.

1868. It was necessary, was it not, to take the ship in straight?—Yes, for that berth.

1869. (*Admiral Sir George Nares.*) There was no room to manœuvre the ship?—No, there was no room; the space was so limited.

1870. (*Sir John Coode.*) Did you see any evidence of a very strong current running at that time?—Yes, I waited for an hour outside in order to let the fresh pass away. As a rule, in the early morning, there is no current. It was just after the cyclone, and it always fluctuates at those times.

1871. Have you formed any idea in your mind of the rate that the current was running at that time?—It must have been going at least three miles an hour. The vessel turned right round and only just cleared.

1872. Then she was set down, if I understand right, close upon the end of the south breakwater, and slewed round in the entrance, her head clearing the south end of the northern pier; she in fact turned in the entrance?—Yes, and I had to drop anchor in the entrance and go full speed astern to save the vessel.

1873. (*Chairman.*) Was there any wind at the time to affect the ship?—No, no wind: it was entirely the current.

1874. (*Admiral Sir George Nares.*) At what rate were you going as you entered the harbour?—I came up slow to the buoy, and then I gave her full speed to shoot the entrance. I often have to do that.

1875. When you say the north buoy you mean the buoy which marks the end of the works?—There are two large buoys immediately outside the entrance, and it is by those buoys that you have to exercise great caution in order to bring the ship towards the wind.

1876. The buoys do not mark the end of the works?—No, they are outside, about 400 feet.

1877. (*Chairman.*) You have often experienced some difficulty in taking ships in?—Yes, we have to be very careful.

1878. Is there any difference in the amount of traffic during the north-east monsoon and the south-west

monsoon?—There is a little difference, we do not get so many steamers.

1879. The traffic choose the particular time of the year which is most suited for them?—Yes. We commence in the month of May; that is our busy time.

1880. Should you like to see the entrance of the harbour narrowed by 100 feet?—No, certainly not.

1881. (*Sir John Coode.*) Would you narrow it at all?—No.

1882. You do not think it would allow of a reduction even to the extent of 50 feet?—No.

1883. (*Chairman.*) It is supposed that it would give smoother water inside, and one of the proposals is that it should be narrowed 100 feet; you think that that is objectionable?—Yes, it will either stop the traffic or will interfere with the traffic.

1884. (*Admiral Sir George Nares.*) How many hours would this strong current be running at one time without ceasing?—I have known it without ceasing as much as three or four days continuously. Then again I have gone out in the morning and found little or no current running, and in the evening it has been running a knot and a half.

1885. But that only occurs when a cyclone is coming?—It occurs at other times as well; you can never depend upon the current at Madras. I have heard commanders of P. and O. steamers who have said they have been sent out of their course 20 miles, and they have had to go up as far as the Armeghan shoal and come back again.

1886. (*Chairman.*) Is the state of the water inside the harbour in bad weather itself sufficient to interfere with the navigation of ships?—No.

1887. I refer to what is described as the nobbly state of the water?—It does not interfere with the draught of water not with the safety of the navigation, because when the sea is so rough as that and the weather is so bad they generally go out and lie off outside until the weather is finer.

1888. Supposing that the sea were setting in preliminary to a cyclone and you were taking a ship to sea, would the change from the state of the water inside of the harbour to meeting the sea on the outside prove any danger to the ship. I mean that inside the harbour you have very good navigation for your long ships, but outside there is a heavy rolling sea and a regular sea; does that make any difference in taking the ship out?—No, it does not.

1889. Is not that because you meet that sea end on?—We meet it end on.

1890. Do you think that if that sea were broadside on it would make it more difficult or dangerous?—I think not.

1891. I mean if the sea were rolling from the outside from south to north, would there be any danger in taking a long ship out if you met it end on?—No.

1892. With the present entrance?—No.

1893. Why not?—Because with the present entrance we meet the sea end on.

1893. (*Admiral Sir George Nares.*) The chairman is supposing that with the present entrance we meet the force of the sea coming from the north instead of from the east, which is really rolling across the harbour's mouth instead of right on?—I have found no difficulty in the north-east monsoon. The sea does roll a little from the north-east sometimes, and it does roll across.

1895. And you do not consider that forms any danger in the entrance?—No. I always hang well up to the northward to the north of the buoy.

1896. (*Sir John Coode.*) I do not think you quite apprehend the Admiral's question. The Admiral says the sea being absolutely across the opening?—No, I do not see that there is any difficulty about it, you would hang well to the north side. Of course steamers generally go out full speed at that time.

1897. Only you want to go full speed coming into the harbour?—No, we do not come in at those dangerous times.

1898. So that while the sea would not interfere with a vessel going out it would interfere with a vessel going in?—Yes, there would be no object in coming inside with a sea like that, because they could do no work, and captains prefer stopping outside till the water is smooth inside, and they can go on with their work. Tug boats will not keep afloat.

1899. (*Chairman.*) Do you think that if the entrance were closed up, it would improve the state of the river in the harbour?—Yes.

1900. I mean as the harbour is now, with the sea coming over the walls?—Yes, it would. The sea coming over the walls does not make any disturbance inside, it falls immediately inside the walls and it appears itself.

1901. Then you think that what does affect the state of the water inside is the sea coming through the entrance?—Yes, through the gaps.

1902. (*Sir John Coode.*) Do you mean now, or before the gaps occurred, while the work stood?—Before that, when the harbour was almost intact, the sea used to roll in then during the south-west monsoon. The sea being from the south-east used to strike in the north-east corner, and steamers or ships lying in that position could do no work. In fact, I have to shift them from there to the other side when a berth is available.

1903. (*Chairman.*) On every occasion there was always one side of the harbour in which you could work?—Yes, only one side.

1904. And that state of the sea inside you think arises solely from the sea that comes through the entrance?—Yes.

1905. (*Sir John Coode.*) Do you think anything could be done to prevent that interruption to the trade inside the harbour which you spoke of just now?—The only thing that I could suggest is closing up the eastern entrance.

1906. Then you would open it up somewhere else. You must have some entrance to the harbour, where would you put the entrance?—On account of the bank increasing at the south side it may be perhaps objectionable on that side, and the north-east side would be the best place under the present arrangement of things, only that in rough or bad weather steamers would not be able to come in perhaps for a few hours, and they would have to wait.

1907. Longer than they do at present?—No, they have to stop out sometimes now.

1908. (*Chairman.*) That is the latest proposition; put yourself in the position of bringing in one of these large steamers which be there through the proposed entrance (*handing plan No. 3 to the witness*). Have you seen this plan No. 3 before?—No, I have not seen that plan.

1909. (*Sir John Coode.*) In the plan that you have before you, which is distinguished as plan No. 3, the yellow plan, you see that the intended entrance is 500 feet wide; the northern arm, would in that case stop at about half-way out of the knuckle, at about the point where the restoration works have arrived at present; then there would be a clear 500 feet, and it would be overlapped by a prolongation as it were of the southern arm overlapping the north wall on the north-east to the extent of about 500 or 600 feet; does that plan conform to your idea of the best entrance that could be made in the north-east part of the harbour?—Looking at the diagram I should say that the north and south wall ought to be extended at least 200 feet more.

1910. Then you think it ought to be about 800 feet long?—Yes, about 800 feet. That would give entire smooth water under the projecting arm for navigating purposes.

1911. (*Chairman.*) Does that opinion hold good during the north-east monsoon?—Yes, the north-east monsoon is what I am looking to. It should be a length and a half of a big steamer.

1912. (*Sir John Coode.*) The overlap should not be less than 800 feet to the northward of an imaginary line being produced from the straight portion of the north pier?—Yes.

1913. (*Chairman.*) Do you think that that projecting arm would catch the current and direct it into the mouth of the harbour?—I have thought of that, and I think not, because there would be no escape in the harbour, and consequently there would be no current, and it would be choked up; at least I do not see that there would be any current.

1914. Still the water set in motion by the current must enter the harbour?—It would a little just inside the entrance, but it would have no direct influence inside the harbour generally.

1915. It would raise the level of the water inside the harbour would it not, and that water would be bound to find its way out again?—Yes, it would be like a double current, a surface current and an underneath current.

1916. In that case you would require an entrance of some considerable depth to provide for the ingress and egress of the water?—Yes.

1917. And merely removing the rubble to something rather more than the ordinary draught of a large ship would not be sufficient?—I would take it all away.

1918. Looking at it from a pilotage point of view, you see no difficulty in taking ships in and out of a north-east entrance any more than you would find in taking them in and out of an easterly entrance?—No; I think there would be less difficulty, because in an easterly entrance, when a ship's head is just inside the harbour, there is all the other part of the vessel in living water, and I should have to come in full speed with the jib set and the engine going full speed ahead, and the helm hard over to counteract the influence of the current.

1919. With the wind behind you, it would be the same in going in at the north-east entrance; would you not also be obliged to keep your engines going at a considerable speed to keep the ship under command?—Yes; it would be sufficient to go slow just to have command of the steerage way of the ship only; but then I should have to drop my anchor in many cases inside the entrance in the north-east monsoon, in order to swing my ship in and then to place her into the berths.

1920. (*Admiral Sir George Nares.*) Which way would you swing her?—I would swing her with her head to the northward.

1921. And with the stern towards the east breakwater, or the stern towards the shore?—The stern towards the east breakwater, because I should have to go astern and with the anchors she must come to the starboard.

1922. (*Sir John Coode.*) Do vessels moor head and stern in the harbour as it now is?—Yes; the stern moorings are only temporary moorings, and they are very convenient.

1923. (*Chairman.*) Speaking from a pilot's point of view, you are in favour of a north-eastern entrance as compared with the present entrance to the eastward?—Yes, I am.

1924. And you are not afraid of running your ship in shore before turning her towards the breakers, as you would have to do?—No; I should come in with a longer sweep.

925. And you are not afraid of a beam sea there, because even when there is no wind it would have a very considerable force on the broadside of the ship as she cleared the projecting arm?—No; I should steer very close to the north end of the projecting arm.

1926. (*Sir John Coode.*) You do not lose sight of the fact that these 800 feet would give you a longer distance to steer in?—No, we want that—we want smooth water.

1927. You would not be afraid, then, to take this entrance with a broadside sea?—No.

1928. (*Admiral Sir George Nares.*) In that case you would not mind the breadth of the entrance being reduced 50 feet less than it is now?—It is only 500 feet now.

1929. But the present entrance is 550 feet?—Then the present entrance should not be reduced.

1930. Do you think that the 500 feet should be increased at the north-east entrance?—No, I think 500 feet would be quite sufficient there.

1931. But 500 feet would not be sufficient for you at the present entrance?—No, you should not reduce the present entrance.

1932. And yet you would be content with a narrower entrance on the north-east end?—Yes, because I come in end on with the current; should there be any current there you come with the current, but in the other case you cross the current.

1933. But would you not have the sea affecting your stern as the bow of the ship got under the protection of the projecting arm?—No, the sea has no influence to my mind. It may make the ship rise and fall a little, but it has not so much influence as the force of the wind.

1934. Has it no influence in yawing the ship?—No.

1935. Then you care only for the current affecting the stern of the ship as the ship passes through an opening?—The current is my biggest enemy.

1936. (*Chairman.*) You are not afraid of the wind?—Not so much as of the current. I have to make some very long sweeps, especially with those old P. and O. steamers which have got very small rudders, and which do not answer readily to their helm. I have to go well up to the northward and come down again, and only then can I get inside the harbour.

1937. (*Sir John Coode.*) You said in answer to Sir George Nares that the sea had no influence in yawing the ship; is that because the roll is so long?—No; it is a short sea.

1938. Would not a short sea yaw the ship?—No, we get two or three seas meeting the vessel in a minute and a half.

1939. Then these short seas come very quick?—Yes, very quick.

1940. And you dread them more than you do the long roll?—I do not dread them. Of course they have not got the same influence over the vessel in short water.

1941. (*Admiral Sir George Nares.*) Do you think that you could tow a sailing ship in through such an entrance with the north-east monsoon?—Yes, in ordinary weather, but not when it is blowing very strong; it would not be advisable.

1942. But you would not dare to tow a vessel in at the present entrance on the east side?—It would require smooth water with little or no current; I have sailed sailing ships in there in fine weather, but not since the harbour has been washed down.

1943. (*Chairman.*) I want to get a clear idea of the sea at Madras; do you ever, or do you often see it smooth enough to put a tug alongside a ship?—Yes, very often I have seen the sea as smooth as this table.

1944. How many times in the course of a week?—I may say one day, or two days, or perhaps three days a week, or perhaps one or two days in every ten days.

1945. (*Sir John Coode.*) And on all occasions is the surf breaking on the beach?—Yes, there is always a roll on the beach, although it may be smooth outside.

1946. The surface may be glassy, but if there is a surf on the beach there must be undulation outside?—There is a little undulation, but as it gets towards the beach it creeps and rolls on the beach.

1947. (*Chairman.*) What description of boat do you use?—Just like a man-of-war's cutter.

1948. Do you ever land on the beach?—No.

1949. Not inside the harbour?—No, we cannot do that.

1950. Do you mean that you cannot land in safety or that you cannot land without getting wet?—I could land in safety, but I should knock the keel of my boat away—at all times of the year I should do that.

1951. In the finest weather?—Yes, in the finest weather. There is always a commotion on the beach, although at the bar it is quite smooth comparatively speaking, yet on the beach there is a surf or sea; so that you cannot land with your boat, at least not with a pull-away boat. You can land with the Masoolah boats.

1952. Was that the case when the harbour was intact?—Yes, just the same. One side was fine and the other side was rough when the harbour was intact.

1953. (*Sir John Coode.*) What you mean is that there would be a swell on the one side or the other according to the monsoon?—Yes, just according to the monsoon.

1954. Were you at Madras on the 12th of November 1881, when the works were damaged?—Yes, I was there. I had been there from the previous March.

1955. Were you in and about the harbour during the whole of the former part of that day?—Yes, I was on the spot.

1956. Do you know what was the condition of the harbour before any damage was done to the seaward face of it, and what was the condition of the sea inside?—Yes.

1957. Can you describe to us what was the condition of the water inside the harbour before the damage took place in the early part of that day; we have been led to understand that the principal damage began to take

place about 11 o'clock?—Yes, I may say it took place before then. You could not see the works, as it was all one mass of foam. It was only when it subsided that we found the east walls were all washed down.

1965. Then the first thing that you observed was the disappearance of the titans?—Yes, between the hours of half-past 10 and 12 they both went.

1966. Up to 10 o'clock what was the condition of the water in the harbour?—All rolling waves.

1967. Regular or irregular?—Regular waves breaking outside the T-end of the pier.

1968. In two cases in the evidence which has been given to us we were told that the sea was very irregular, and it was described as a boiling pot?—That was between 10 o'clock and 12; then the wind changed. When the wall was washed down, the wind was about north-north-west, I should say.

1969. We want to know what was the condition of the water in the harbour before any damage was done to the works; you say that the sea within the harbour prior to that was regular, but we have been told that it was very irregular, and it has been described to us as a boiling pot?—I did not see that it was irregular; the sea had to come in straight to the westward, from east to west.

1970. (*Admiral Sir George Nares.*) Was it irregular near the piers?—Yes, but it was regular out towards the entrance.

1971. (*Sir John Coode.*) We have been told that one of the early effects of the works on the beach was to throw down all the sand and leave a vertical face of several feet against the shore; did you notice that?—No, I saw nothing of the kind; our beach has different features almost twice a week.

1972. Was there in fact a vertical face of something like four or five or six feet?—Yes.

1973. And it went down actually below the water level?—Yes, at other times we find it gradually slopes off.

1974. Have you any idea how far below the main sea level that vertical face would extend?—No, it cuts down right vertically, where the two proposed jetties were to be.

1975. If that was so the sea would not break and become aerated on the sloping beach in the ordinary way, it would rebound from this vertical face?—Yes, there would be a recoil, it would cut away the sand.

1976. What would be the effect of that upon the sea in the harbour, because it must have caused a very irregular and dangerous wave?—After the titans fell in, it was like a boiling cauldron.

1977. We were told that no money would induce the men to go out and rescue the poor fellows in the hopper barges who were in danger?—I offered to go out myself, and the office offered 100 rupees, but they would not go.

1978. You think that it would have been a service of the greatest danger?—Yes. I might have gone off at half-past 9, but after that it would have been pure madness to have gone out. That was after the pier was washed in.

1979. Then the pier did afford a considerable amount of shelter?—It afforded a little shelter.

1980. Have you heard that it is proposed to raise the piers up to 12 feet above the sea level instead of 6 feet, as they were before?—No, I had not heard that.

1981. Do you think that that would be an advantage?—If that is the case we should have a nice quiet harbour.

1982. Have you watched the action of the wave-breaker that is put down on the north and south?—Yes, that is very useful, it destroys the force of the wave.

1983. Does it or does it not diminish the force of the sea and the quantity of water that comes over the piers?—It scarcely comes over at all now.

1984. I mean it would be very useful in weather during which the sea would have come over but for those blocks?—Yes, but for these blocks it certainly would come over.

1985. Then that is advantageous?—Yes, certainly.

1986. And irrespective of the benefit to be derived from the mere protecting of the visible portion of the work they are of great benefit in keeping the sea from coming over the wall into the harbour?—Yes, a very great benefit.

1987. Then, as I gather from your evidence, if the difficulty of the current could be got rid of, it does not matter to you much where the entrance is to be?—Not particularly.

1988. But the current I think you said is your biggest enemy?—It is my biggest enemy.

1989. Do you think if the works were formed on the lines indicated on this plan No. 3—prolonged as you have suggested—that there should be an overlap of about 600 feet, you would have no difficulty in getting a vessel in at any time, or under any circumstances?—I would not say that, because we have times when the wind has been very strong, and we could not even get out to a ship sometimes.

1990. You could get in and out at times when you would not venture to get in and out of the present entrance?—Yes, I could certainly.

1991. Even though it would be 50 feet narrower than the present entrance, which is 150 feet, as Sir George Nares pointed out to you according to plan No. 3?—Yes.

1992. Do you think that it ought to be less than 150 feet?—No, I think not.

1993. You think that that would suffice?—It would do, but of course I should like to get more.

1994. If you had more you would be opening the harbour more inside?—Yes, but I think 300 feet would do. The only thing that we should want is a protection by means of the overlap that I have previously referred to.

1995. Have you seen at any time, or under any circumstances, a belt of discoloured water coming up from the southward and passing along in front of the works?—I have often seen discoloured water, but not a belt of water particularly. I have seen discoloured water running to the south-east.

1996. We have heard of a belt of water discoloured with sand coming up from the southward, and then running along to the right knuckle of the south pier, and there has been clear water between that and the shore; have you ever seen that?—Yes, I have often seen it.

1997. Does this belt of discoloured water continue past Madras for any considerable distance?—It goes about a mile past, and then it disappears. It may perhaps go further, but it disappears from our view.

1998. Have you ever been up to the northward so as to be able to say whether this sand discoloration disappears or whether the current goes on?—I do not know.

1999. But merely say that it is lost to sight?—Yes, it is merely lost to sight.

2000. What is about the breadth of this discoloured sandy water?—I should think it is about 800 or 1,000 feet broad.

2001. What is the breadth of clear water inside between this discoloured water and the shore?—Just almost the length of the arms.

2002. Then it is all clear water between this discoloration and up to close to the beach?—Yes, pretty close up to the beach.

2003. There of course it would be more or less discoloured by the sand in suspension, arising from the surf?—Yes.

2004. Do you think it would be about 300 feet broad?—Yes, if not more.

2005. How far to the south have you traced it, or have you traced it from the southward so as to know where it originates?—I could not trace it, but I very often see it passing by.

2006. All that you are able to say is that you see the discoloration until it is lost to sight by reason of the distance, and you are not able to say whether the water is or is not discoloured more than about a mile in either direction; that is what you mean?—That is so.

2007. Have you ever considered what that is due to, or how it happens that that narrow belt of sandy water is there?—I can only attribute it to eddy currents. One of our divers, when outside diving for lost anchors belonging to native craft, has told me that he has gone down below and found as many as three different currents before he has got to the bottom in nine fathoms, and when he has got to the bottom he has had to hold on to the bottom, and has seen shells passing by.

2008. (*Admiral Sir George Nares.*) Is there any discoloration with those strongest currents in the north-east monsoon?—Yes, not on the north side. It seems to form a discoloration as it passes the entrance to the harbour, and strikes away to the south-east.

2009. At the actual entrance to the harbour is there a discoloration?—Sometimes in dead water it seems to hang about there a little.

2010. Is there discoloration at the mouth of the harbour with the southerly monsoon?—Very often there is a sandy colour in the water, but even then there is little or no force of water. I do not know how to account for it; there is little or nothing in the way of a current, but yet there is a little discoloration hanging about sometimes, especially in the south-west monsoons.

2011. With blue water outside?—Yes, with blue water outside, further out in the offing.

2012. (*Sir John Coode.*) Do you see the discoloured water enter the harbour, under any circumstances?—It seems to hang about the entrance and it passes away again.

2013. But it does not run into the harbour?—No; it seems to make a little bit of a twist and it will then pass on.

2014. (*Admiral Sir George Nares.*) But the flood tide sets to the north?—Yes.

2015. There is a greater discoloration, is there not, at the mouth of the harbour with the flood tide than with the ebb?—Yes.

2015a. And the tendency would be to bring the discoloured water into the harbour?—It does not come into the harbour; it hangs about the entrance, and yet I find no difference in my soundings for these last five or six years.

2016. (*Chairman.*) We have asked you a good many questions about taking ships in, I should like to ask you some questions about taking ships out. Supposing that you were called upon to clear the harbour in consequence of a cyclone coming on; do you ever have at the commencement of a cyclone the wind from the southward?—No, never.

2017. So that you would not be exposed to danger in bringing out a ship with the wind under her tail?—No, we get the wind under her tail because we get the wind north-west at the present time. The wind is generally about two points abaft the beam now.

2018. Then you think that at the north-east entrance you would have an advantage also in taking ships out?—Yes, because you can steam against the wind, and you have got your enemy to deal with.

2019. Could you show us about the position where the moorings are that you have in the harbour. Since the construction of the harbour I believe you commenced to lay down moorings, did you not?—Yes, the Harbour Board have laid down one mooring and partly finished another.

2020. Then there was only one set of moorings completed?—Yes, only one, and that was in the south-west corner.

2021. Where was it proposed to lay other moorings for large vessels?—That I do not remember; I do not know what the plans were. The way we have them now is right across the harbour.

2022. Have you any moorings there now?—Yes, I am utilising two that were laid down by the Harbour Board, and then I have three more where we have put our own anchors.

2023. Are those for holding large ships?—Yes, in ordinary weather only.

2024. Does that give them swinging berths?—Just sufficient room only.

2025. Supposing the position of the entrance changed to the north-east corner, do you think that you would be able to moor ships upon the eastern face, or would not that be in the way of the entrance?—That would be in the way of the entrance decidedly.

2026. The whole of it?—For two-thirds of the distance.

2027. Then you do not think you would gain space for mooring ships by changing the entrance?—You might gain about two berths. I do not think you would gain any more.

2028. (*Sir John Coode.*) You will find here three skeleton plans of the harbour of Madras, No. 1 being the harbour in its present state; No. 2 being the harbour with the eastern entrance closed, the straight portion of the seaward face of the south pier being prolonged to the north-east until it overlaps the entrance suggested to be formed over what is now, or what was, the southern portion of the north pier; and No. 3 being the yellow plan similar to that before you, a description of which is already upon the notes. I think it would facilitate the object which we have in view if you would just indicate to us with a pencil the positions in which ships should be moored in your opinion according to these three plans?—I could do that. (*The witness sketched out on plan No. 1 the space which he would leave clear inside the harbour for vessels entering or leaving the harbour.*)

2029. All the rest within the pencil lines which you have indicated would be available for moorings?—Yes.

2030. Would you do the same thing with regard to No. 2?—I am afraid that in the case of No. 2, looking at the way the contour of it is given we should get the sea in there (*pointing to the plan*).

2031. Then you disapprove of No. 2?—Yes, in that style.

2032. Because you think it would let too much sea into the harbour?—Yes, it would let too much sea in.

2033. Now passing from No. 2 and coming to No. 3, what space would you leave open in case of the works being altered, and constructed as in No. 3 plan?—In this one I should have to moor my vessels quite differently from what I do now. They are moored now east and west, but in No. 3 I should have to moor them north and south.

2034. At all times?—Yes, at all times, advisedly, because a part of that lies to the north-west, and in the case of hurricanes vessels would always be in a position for going out of the harbour when the weather was suspicious.

2035. And you could not venture to do that with the harbour as it is at present?—Not to moor them in that way.

2036. Then you would moor them in different ways according to the different seasons?—Yes, but in No. 3 I should always moor them north and south, whatever the season of the year might be.

2037. Now will you indicate to us upon the sketch No. 3 what clear space you would leave for vessels entering or leaving the harbour?—I should leave at least 1,500 feet north and south, and about 1,000 feet east and west, and then the other part of the harbour could be utilised—that would give you three long vessels in the outside berth, and four long vessels in the inside berth in five fathoms of water.

2038. What you have given to us, as I understand, is the clear space which you would leave immediately inside the entrance, but now will you just tell us further what clear space you would leave in there to enable vessels to get into the western part of the harbour, because you must leave a clear course towards the jetty or towards the shore in some direction?—Yes, and therefore when I come in at the entrance, dropping my anchor, it would be necessary to have a tender to come alongside the vessel, and not utilise the ship's engines very much. The vessel must be placed in the berth by the tender.

2039. The point of my question is this: You are speaking now of the mode in which you would handle your ship; but what I want to know is what clear space you would have to leave according to each of these suggestions, No. 1 and No. 2. You would not block the space up entirely?—We should have at least the ship's own length and a half; besides in case of anything going wrong she would drop her anchor and let her slew right into the first moorings; and once there of course the ship might be moored.

2040. Ships would be moored both in the north and south portions of the harbour, but between the tiers there should be a clear space left of a certain width?—It would be the length of one vessel, it would not interfere with the buoys and moorings.

2041. What space would you require for that?—750 feet at least, or a length and a half of a vessel.

2042. About the central portion of the harbour?—Yes.

2043. That would be the same in either case?—Yes, the same in either case. (*The witness sketched on the plan*

how he proposed to lay the moorings.) The same thing would apply in the case of No. 1.

2037. The clear space in the central portion of the harbour you would leave in the case of No. 1?—Yes.

2038. And in the case of No. 3 you would have very nearly the whole of the southern half of the harbour available for moorings?—Yes.

2039. Do you think that the water would be sufficiently quiet in all weathers excepting in cyclones?—Yes, with an arm like that.

2040. That is always supposing that the arm was extended with an overlap of 800 feet, as you have described it?—Yes.

2041. According to this plan No. 3, would you indicate on it what would be the easternmost tier of moorings on the north side of the harbour?—Yes *(the witness pointed out the same on the plan)*, you could not go much less than 500 feet northwards from the extreme end.

2042. You must leave a clear space of at least 500 feet?—Yes, of course; it is an understood thing that those vessels would be moored at permanent moorings, and in that case of course they would be safe, but if they were allowed to swing round you must get a bigger scope.

2043. Then I gather from what you have told us that you consider that the space within the harbour would be economised to a much greater extent by plan No. 3 than by plan No. 1?—Yes.

2044. And it would be more convenient, inasmuch as the moorings, when once put down, would remain permanent, and a ship could always be moored, and you would never have occasion to change the direction of the moorings?—No, they would be always moored north and south.

2045. And you think it would be imperative to make such a change in the case of No. 1, which was the harbour as it stood before the cyclone of 1881?—Yes.

2046. *(Chairman.)* Has it ever struck you that if plan No. 3 were adopted ships would be able to ride out a cyclone in the harbour?—I have every reason to believe that they would be able to ride out a cyclone inside if they only had the wind to contend with, but I think they would have to cast off at the stern moorings and keep right end on to the wind.

2047. Should you have room for that?—Yes.

2048. In laying down your moorings you would be obliged as a matter of fact to give the ships swinging berths?—Yes, you must give them swinging berths.

2049. Do you think from what you have seen of the cyclone (I do not mean only the cyclone of 1881 but also this last one in May last year) that any works put up there would stand?—Yes, from what I have seen last year, we had five cyclones last year.

2050. *(Sir John Coode.)* Is not that a thing without a precedent?—No, I think not, there was one in May, one on the 9th of November, and one on the 9th of December, but nobody has ever seen such terrific ones. We had a cyclone burst in the centre of the harbour.

2051. *(Admiral Sir George Nares.)* Was the harbour affected most by the wind or by the sea?—The harbour was most affected by the sea.

2052. And you say that a cyclone sea came into the harbour five times last year?—Yes, five times last year.

2053. *(Chairman.)* One of the proposals before us is to commence clearing away for a north-east entrance at once, trusting to chance as to the sea in the harbour while the works are in their present incomplete state. Should you feel inclined to do that or to wait till the works are constructed on the old plan, with the additional height which is proposed in the other scheme?—At present the gaps are so extensive that I do not know that it would make much difference to the force of the sea inside the harbour.

2054. Do you think that the additional depth of water that may be necessary for an entrance will make but little difference in the state of the sea inside the harbour?—I do not think it would make much difference. Of course it would make a little, but not to the extent that would make the navigation any more difficult.

2055. *(Sir John Coode.)* That might be put up with during the time in which the works were under construction?—Yes.

2056. *(Chairman.)* What is the state of the bottom in the harbour, is it clean sand?—It is clean sand on the north side, but in the south-east corner it is dirty sand—muddy stuff.

2057. Is it increasing very rapidly?—No, I think it is pulpy matter which is easily washed away again, it does not accumulate there at all.

2058. Is it washed away?—It does not seem to me to make any difference in my soundings on that side.

2059. Does the return current, which must find its way out from it, scour the harbour?—Yes, it does scour the harbour.

2060. Do you think that with the entrance at the north-east and protected by that protecting arm you would get the same scour?—I do not think you would.

2061. And therefore you think there is a chance that the harbour would become fuller and more unhealthy?—I fancy that we shall always have to have a dredger in the harbour, because there would be no escape for any sediment that may possibly come in, or for any filth from different steamers that are lying there, because we cannot always watch them.

2062. *(Sir John Coode.)* Could you have worked the dredger in the harbour, as it existed prior to the cyclone of 1881?—Was the water sufficiently quiet to admit of the dredger being worked?—At certain times, but there would be no protection for it.

2063. There is some weather, is there not, in which a dredger must either leave or be destroyed?—Yes.

2064. Do you think there would be sufficient protection in the harbour allored according to plan 3?—Yes, I think so.

2065. Do you think that at all times and in all weathers a dredger would be safe?—Yes.

2066. In what part of the harbour would you moor the dredger that she should be so?—In the north-east monsoon in the north-west corner. In fact there is always a place for her, because in the south-west monsoon the sea is smooth.

2067. And you think that she would be safe at all times in the north-west corner?—Yes.

2068. Then you are decidedly of opinion that there is no silting up of anything of any moment within the harbour up to the present time except just on the beach?—Quite so. Above the harbour the sand is perfectly clean, and there is no difference in my soundings there: the north side retains its position just the same as before, whereas on the south side there are different appearances.

2069. *(Admiral Sir George Nares.)* If a north-east entrance is opened it must overlap so as to keep out the north-east sea?—Yes it must.

2070. If the sea with the north-east monsoon were allowed to enter the harbour it would interfere with the commercial aspect of the harbour?—Yes.

2071. But would it affect the vessels themselves?—It would affect the vessels in the way of carrying on their labour, they would not be able to get as much work done.

2072. If No. 2 plan were adopted then the whole of the berthage along the eastern face as prolonged would be affected during the north-east monsoon?—Yes undoubtedly so.

2073. What is the course that vessels take when passing to the southward after leaving the harbour?—About south 21° east—about south-south-east.

2074. That obliges them to be beam on or nearly beam on to the heavy rollers?—Yes.

2075. For what distance outside the harbour?—For about half a mile.

2076. Then vessels now wherever the entrance is placed must necessarily, in order to steer their proper course, run for some distance with the sea abeam?—Yes, because the sea is from the eastward and they must go with the sea abeam.

2077. The course to Calcutta being north-east they must in a north-east monsoon be either bows on or stern on?—Either bows on or stern on.

2078. Could you give us the bearing of how one pier end should overlap the other at the north-east entrance? Should it be more northerly than north-easterly to keep the north-east sea out?—I should say not.

2079. The yellow plan shows the pier ends ending north-east from each other?—Yes, I do not think you could make any improvement upon this.

2080. Would that keep the sea out?—Yes, with a little further extension.

2081. Without the further extension that you have proposed would that design keep the north-east sea out?—Yes it would keep the sea out from the harbour, but it would make the navigation a little more difficult and intricate.

2082. Then so far as the harbour is concerned you would be satisfied with that yellow plan?—Yes.

2083. The sea with the north-east monsoon being inclined to roll in parallel with the beach?—Not quite parallel with the beach—about east-north-east. Whether the current brings it down along shore with it, or whether there is little or no current, it comes in more directly from the eastward—about east-north-east. In plan No. 3 the end of the northern arm curves inwards; I would suggest that it should curve outwards so as to throw off the current.

2084. You suggest that as an improvement?—Yes.

2085. *(Sir John Coode.)* You are aware that that would be attended with a great deal more expense, because it would necessitate the removal of a considerable portion of the work which is now being made; but even so, you would wish to see the outer arm curved to the north instead of to the south?—Yes; to throw this gives the current an opportunity to enter.

2086. Pardon me, if it will admit the current it will let it out also?—The current slips in here and runs out again.

2087. What you mean is this: that the current runs to the south along the shore and strikes the northern face of the north pier and runs along it?—Yes.

2088. And you apprehend that that current might interfere with vessels entering or leaving the harbour?—A little.

2089. If this current is not very strong is would be a question whether it would be worth the expense; do you think it would be sufficient to warrant some outlay in making the change of entrance as you have pointed out?—Perhaps not to go to an enormous expense.

2090. What is the strength of that current that runs along the north pier, at its worst, do you think?—Here I should think it runs about a mile and a half. I only mentioned this because I thought it was a little improvement.

Captain J. H. TAYLOR further examined.

2103. *(Chairman.)* Have you anything further which you wish to state to the Committee?—I should like to alter the evidence which I gave the other day in one particular. I was asked whether a ship coming out and undergoing some slight stoppage to her machinery would not be in danger from the proximity of the surf. I thought at the time that it referred to bad weather, and I shaped my answer accordingly; but the fact is that the British India steamers and the railway steamers always transact their business north of the harbour in five-fathom water all the year round, excepting those few days when no vessel can move, and the native ships all anchor on the north side of the harbour in about five fathoms of water. From the railway company's jetty adjoining the north pier there is a piece of land which I have rented to the railway company to land their stores at, and their ships anchor off this place in five fathoms of water all the year round, excepting on such days as no other business could be transacted in the harbour.

2104. How are those stores landed?—In boats they land the railway stores, and the coals.

2105. How do they land their heavy stores, such as boilers?—At a jetty. If they do not; if there is anything that they do not like to trust to it, the steamer comes in and we land them at the pier within the harbour, but that has only occurred once, I think. The north pier would be occupied entirely by vessels landing different railway stores and timber in between 5 fathoms and 7½ fathoms; the projecting arm will be in 8 fathoms.

2106. Or a ship in case of her engines being temporarily disabled would anchor there?—Yes, in case of her engines being temporarily disabled. The same accident would occur at the old entrance, and probably it would be worse there because they would have no room to swing her. If the ship was to become disabled in the middle of the old opening she would tail on one or other of the piers, whereas here there is plenty of room to move her opposite the entrance to the proposed north-east pier. On the south side, on the opposite side of the harbour, the horse ships land their horses, and they can never approach inside the elbow; their horses are landed on the south beach. The horse ships are never able to approach nearer than what is described on the contour line as 7½ or 8 fathoms.

2107. Do you mean by that, that all the cavalry horses are landed there?—The Australian horses are landed there. The cavalry horses are landed on the beach inside the harbour. Those people would have to pay heavy dues inside the harbour, but the Australian dealers do not pay them outside.

2108. How do you land the horses outside?—Each one has a Masoolah boat, and directly they come to the shore the boat broaches to of her own accord, and they tip her over and the horses are handled out. And in the same way in getting in, they upset the boat and back the horse in, and they have a rope under his tail and a rope on his head, and after a little hallooing the horse makes a jump into the boat, and then they tip the boat up and there he is; there is never any difficulty about it.

2109. *(Admiral Sir George Nares.)* Do vessels anchor on the north side of the north pier in the north-east monsoon?—Yes, timber ships and railway ships do.

2110. I ask you the question because the last witness that we had gave distinct evidence that throughout the north-east monsoon that anchorage was not used?—The British India Company come every fortnight with timber, and they always land it there whatever the monsoon is, unless the weather is such as really to prevent it.

Capt. J. H. Taylor.

2091. *(Admiral Sir George Nares.)* Would not this easterly current along the outer face of the north pier affect your ship in entering with a north-east entrance, considering that the entrance is only proposed to be 500 feet, because it would set you against the outer breakwater—you see that there is a current running to the eastward along the outer part of the north pier?—It runs south-east.

2092. It runs along the pier end?—Yes.

2093. With an entrance only 500 feet wide, which is 50 feet less than the present entrance, would not that affect the ship and set you towards the outer breakwater?—By the time it would get to that point I am of opinion that it would lose its force, there would be a recoil from the overlapping portion of the eastern arm.

2094. And it would not meet you directly abeam?—No.

2095. *(Sir John Coode.)* If that were so then I suppose you would not argue for the alteration of this arm?—No, I only just mentioned it as an improvement as I thought.

2096. I notice that you sketched in pencil on this No. 3 plan for the overlap 800 feet; do you still think that that would not be too much?—No, I do not think it would be too much; you would require all that.

2097. You still think that by hugging the north end of the prolonged pier you would find no difficulty in getting in at this 500-feet entrance?—No, I think not.

2098. *(Admiral Sir George Nares.)* But with the current setting down from the northward, at 2 or 3 knots an hour, you could not possibly hug the north end of the pier?—If that were to occur we should not get a ship in there at all.

2099. The difficulty is with the entrance anywhere?—Yes.

2100. *(Chairman.)* Do you realise that to make a change in the plan of the harbour a great deal of what has already been thrown into the harbour will have to be picked up again and carried away, and then, as you cannot afford any protection for the dredgers, it must be done by divers; have you realised that?—I have thought over it.

2101. Can you give us any idea at all of the proportion of days in the course of a year in which the divers could work?—Yes, I should say they could work at least 10 months out of 12, fully that.

2102. Picking up the stuff?—Yes, picking up the stuff.

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how he proposed to lay the moorings.) The same thing would apply in the case of No. 1.

2037. The clear space in the central portion of the harbour you would leave in the case of No. 1?—Yes.

2038. And in the case of No. 3 you would have very nearly the whole of the southern half of the harbour available for moorings?—Yes.

2039. Do you think that the water would be sufficiently quiet in all weathers excepting in cyclones?—Yes, with an arm like that.

2040. That is always supposing that the arm was extended with an overlap of 800 feet, as you have described it?—Yes.

2041. According to this plan No. 3, would you indicate on it what would be the easternmost tier of moorings on the north side of the harbour?—Yes. (*He withdrew pointed out the same on the plan*). you could not go much less than 500 feet northwards from the extreme end.

2042. You must leave a clear space of at least 500 feet?—Yes, of course; it is an understood thing that those vessels would be moored at permanent moorings; and in that case of course they would be safe, but if they were allowed to swing round you must get a bigger scope.

2043. Then I gather from what you have told us that you consider that the space within the harbour would be economised to a much greater extent by plan No. 3 than by plan No. 1?—Yes.

2044. And it would be more convenient, inasmuch as the moorings, when once put down, would remain permanent, and a ship could always be moored, and you would never have occasion to change the direction of the moorings?—No, they would be always moored north and south.

2045. And you think it would be imperative to make such a change in the case of No. 1, which was the harbour as it stood before the cyclone of 1881?—Yes.

2046. (*Chairman.*) Has it ever struck you that if plan No. 3 were adopted ships would be able to ride out a cyclone in the harbour?—I have every reason to believe that they would be able to ride out a cyclone inside if they only had the wind to contend with, but I think they would have to cast off at the stern moorings and keep right end on to the wind.

2047. Should you have room for that?—Yes.

2048. In laying down your moorings you would be obliged as a matter of fact to give the ships swinging berths?—Yes, you must give them swinging berths.

2049. Do you think from what you have seen of the cyclone (I do not mean only the cyclone of 1881 but also this last one in May last year) that any works put up there would stand?—Yes, from what I have seen last year, we had five cyclones last year.

2050. (*Sir John Coode.*) Is not that a thing without a precedent?—No, I think not, there was one in May, one on the 9th of November, and one on the 9th of December, but nobody has ever seen such terrific ones. We had a cyclone burst in the centre of the harbour.

2051. (*Admiral Sir George Nares.*) Was the harbour affected most by the wind or by the sea?—The harbour was most affected by the sea.

2052. And you say that a cyclone sea came into the harbour five times last year?—Yes, five times last year.

2053. (*Chairman.*) One of the proposals before us is to commence clearing away for a north-east entrance at once, trusting to chance as to the sea in the harbour while the works are in their present incomplete state. Should you feel inclined to do that or to wait till the works are constructed on the old plan, with the additional height which is proposed in the other scheme?—At present the gaps are so extensive that I do not know that it would make much difference to the force of the sea inside the harbour.

2054. Do you think that the additional depth of water that may be necessary for an entrance will make but little difference in the state of the sea inside the harbour?—I do not think it would make much difference. Of course it would make a little, but not to the extent that would make the navigation any more difficult.

2055. (*Sir John Coode.*) That might be put up with during the time in which the works were under construction?—Yes.

2056. (*Chairman.*) What is the state of the bottom in the harbour, is it clean sand?—It is clean sand on the north side, but in the south-east corner it is dirty sand—muddy stuff.

2057. Is it increasing very rapidly?—No, I think it is pulpy matter which is easily washed away again, it does not accumulate there at all.

2058. Is it washed away?—It does not seem to me to make any difference in my soundings on that side.

2059. Does the return current, which must find its way out from it, scour the harbour?—Yes, it does scour the harbour.

2060. Do you think that with the entrance at the north-east and protected by that protecting arm you would get the same scour?—I do not think you would.

2061. And therefore you think there is a chance that the harbour would become fouler and more unhealthy?—I fancy that we shall always have to have a dredger in the harbour, because there would be no escape for any sediment that may possibly come in, or for any filth from different steamers that are lying there, because we cannot always watch them.

2062. (*Sir John Coode.*) Could you have worked the dredger in the harbour, as it existed prior to the cyclone of 1881? Was the water sufficiently quiet to admit of the dredger being worked?—At certain times, but there would be no protection for it.

2063. There is some weather, is there not, in which a dredger must either leave or be destroyed?—Yes.

2064. Do you think there would be sufficient protection in the harbour altered according to plan 3?—Yes, I think so.

2065. Do you think that at all times and in all weathers a dredger would be safe?—Yes.

2066. In what part of the harbour would you moor the dredger that she should be so?—In the north-east monsoon in the north-west corner. In fact there is always a place for her, because in the south-west monsoon the sea is smooth.

2067. And you think that she would be safe at all times in the north-east corner?—Yes.

2068. Then you are decidedly of opinion that there is no silting or shoaling up of any moment within the harbour up to the present time except just on the beach?—Quite so. Above the harbour the sand is perfectly clean, and there is no difference in my soundings there; the north side retains its position just the same as before, whereas on the south side there are different appearances.

2069. (*Admiral Sir George Nares.*) If a north-east entrance is opened it must overlap so as to keep out the north-east sea?—Yes it must.

2070. If the sea with the north-east monsoon were allowed to enter the harbour it would interfere with the commercial aspect of the harbour?—Yes.

2071. But would it affect the vessels themselves?—It would affect the vessels in the way of carrying on their labour, they would not be able to get as much work done.

2072. If No. 2 plan were adopted then the whole of the berthage along the eastern face as prolonged would be affected during the north-east monsoon?—Yes, undoubtedly so.

2073. What is the course that vessels take when passing to the southward after leaving the harbour?—About south 21° east—about south-south-east.

2074. That obliges them to be beam on or nearly beam on to the heavy rollers?—Yes.

2075. For what distance outside the harbour?—For about half a mile.

2076. Then vessels now wherever the entrance is placed must necessarily, in order to steer their proper course, run for some distance with the sea abeam?—Yes, because the sea is from the eastward and they must go with the sea abeam.

2077. The course to Calcutta being north-east they must in a north-east monsoon be either bows on or stern on?—Either bows on or stern on.

2078. Could you give us the bearing of how one pier end should overlap the other at the north-east entrance? Should it be more northerly than north-easterly to keep the north-east sea out?—I should say not.

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2079. The yellow plan shows the pier ends ending north-east from each other?—Yes, I do not think you could make any improvement upon this.

2080. Would that keep the sea out?—Yes, with a little further extension.

2081. Without the further extension that you have proposed would that design keep the north-east sea out?—Yes it would keep the sea out from the harbour, but it would make the navigation a little more difficult and intricate.

2082. Then so far as the harbour is concerned you would be satisfied with that yellow plan?—Yes.

2083. The sea with the north-east monsoon being inclined to roll in parallel with the beach?—Not quite parallel with the beach—about east-north-east. Whether parallel with the beach—about east-north-east. Whether the current brings it down along shore with it, or whether there is little or no current, it comes in more directly from the eastward—about east-north-east. In plan No. 3 the end of the northern arm curves inwards; I would suggest that it should curve outwards so as to throw off the current.

2084. You suggest that as an improvement?—Yes.

2085. (*Sir John Coode.*) You are aware that that would be attended with a great deal more expense, because it would necessitate the removal of a considerable portion of the work which is now being made; but even so, you would wish to see the outer arm curved to the north instead of to the south?—Yes; to throw the current away. Now if there is any tendency at all this gives the current an opportunity to enter.

2086. Pardon me, if it will admit the current it will let it out also?—The current slips in here and runs out again.

2087. What you mean is this: that the current runs to the south along the shore end and strikes the northern face of the north pier and runs along it?—Yes.

2088. And you apprehend that that current might interfere with vessels entering or leaving the harbour?—A little.

2089. If this current is not very strong it would be a question whether it would be worth the expense; do you think it would be sufficient to warrant some outlay in making the change of entrance as you have pointed out?—Perhaps not to go to an enormous expense.

2090. What is the strength of that current that runs along the north pier, at its worst, do you think?—Here I should think it runs about a mile and a half. I only mentioned this because I thought it was a little improvement.

2091. (*Admiral Sir George Nares.*) Would not this easterly current along the outer face of the north pier affect your ship in entering with a north-east entrance, considering that the entrance is only proposed to be 500 feet, because it would set you against the outer breakwater—you see that there is a current running to the eastward along the outer part of the north pier?—It runs south-east.

2092. It runs along the pier end?—Yes.

2093. With an entrance only 500 feet wide, which is 50 feet less than the present entrance, would not that affect the ship and set you towards the outer breakwater?—By the time it would get to that point I am of opinion that it would lose its force, there would be a recoil from the overlapping portion of the eastern arm.

2094. And it would not meet you directly abeam?—No.

2095. (*Sir John Coode.*) If that were so then I suppose you would not argue for the alteration of this arm?—No, I only just mentioned it as an improvement as I thought.

2096. I notice that you sketched in pencil on this No. 3 plan for the overlap 800 feet; do you still think that that would not be too much?—No, I do not think it would be too much; you would require all that.

2097. You still think that by hugging the north end of the prolonged pier you would find no difficulty in getting in at this 500-feet entrance?—No, I think not.

2098. (*Admiral Sir George Nares.*) But with the current setting down from the northward, at 2 or 3 knots an hour, you could not possibly hug the north end of the pier?—If that were to occur we should not get a ship in there at all.

2099. The difficulty is with the entrance anywhere?—Yes.

2100. (*Chairman.*) Do you realise that to make a change in the plan of the harbour a great deal of what has already been thrown into the harbour will have to be picked up again and carried away, and then, as you cannot afford any protection for the dredgers, it must be done by divers; have you realised that?—I have thought over it.

2101. Can you give us any idea at all of the proportion of days in the course of a year in which the divers could work?—Yes, I should say they could work at least 10 months out of 12, fully that.

2102. Picking up the stuff?—Yes, picking up the stuff.

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Capt. J. H. Taylor.

2103. (*Chairman.*) Have you anything further which you wish to state to the Committee?—I should like to alter the evidence which I gave the other day in one particular. I was asked whether a ship coming out and undergoing some slight stoppage to her machinery would not be in danger from the proximity of the surf. I thought at the time that it referred to bad weather, and I shaped my answer accordingly; but the fact is that the British India steamers and the railway steamers always transact their business north of the harbour in five-fathom water all the year round, excepting those few days when no vessel can move, and the native ships all anchor on the north side of the harbour in about five fathoms of water. From the railway company's jetty adjoining the north pier there is a piece of land which I have rented to the railway company to land their stores at, and their ships anchor off this place in five fathoms of water all the year round, excepting on such days as no other business could be transacted in the harbour.

2104. How are those stores landed?—In boats they land the railway stores, and the coals.

2105. How do they land their heavy stores, such as boilers?—At a jetty. If they do not; if there is anything that they do not like to trust to it, the steamer comes in and we land them at the pier within the harbour, but that has only occurred once, I think. The north pier would be occupied entirely by vessels landing different railway stores and timber in between 5 fathoms and 7½ fathoms; the projecting arm will be in 8 fathoms.

2106. Or a ship in case of her engines being temporarily disabled would anchor there?—Yes, in case of her engines being temporarily disabled. The same accident would occur at the old entrance, and probably it would be worse there because they would have no room to swing her. If the ship was to become disabled in the middle of the old opening she would tail on one or other of the piers, whereas here there is plenty of room to move opposite the entrance to the proposed north-east pier. On the south side, on the opposite side of the harbour, the horse ships land their horses, and they can never approach inside the elbow; their horses are landed on the south beach. The horse ships are never able to approach nearer than what is described on the contour line as 7½ or 8 fathoms.

2107. Do you mean by that, that all the cavalry horses are landed there?—The Australian horses are landed there. The cavalry horses are landed on the beach inside the harbour. Those people would have to pay heavy dues inside the harbour, but the Australian dealers do not pay them outside.

2108. How do you land the horses outside?—Each one has a Masoolah boat, and directly they come to the shore the boat broaches to of her own accord, and they tip her over and the horses are bundled out. And in the same way in getting in, they upset the boat and back the horse in, and they have a rope under his tail and a rope on his head, and after a little hallooing the horse makes a jump into the boat, and then they tip the boat up and there he is; there is never any difficulty about it.

2109. (*Admiral Sir George Nares.*) Do vessels anchor on the north side of the north pier in the north-east monsoon?—Yes, timber ships and railway ships do.

2110. I ask you the question because the last witness that we had gave distinct evidence that throughout the north-east monsoon that anchorage was not used?—The British India Company come every fortnight with timber, and they always land it there whatever the monsoon is, unless the weather is such as really to prevent it.

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2111. But with a strong north-east monsoon they would have to clear out?—Yes, they would not attempt to stop there in a strong north-east monsoon, but strong monsoons are very rare. I do not remember any cases worth speaking of at all in which the British India Company have been unable to land timber there.

2112. (*Chairman.*) Would you say half a dozen times in the course of the north-east monsoon or a dozen times?—A dozen times perhaps.

2113. Then they would have to wait perhaps a day?—They would have to land there if possible, or else the consignee is subjected to great expense in having his timber carted up to the depôt.

2114. If the weather is such that he cannot land it on the north side of the harbour he takes it round to the south side, does he not?—Yes, if he gets special permission from the collector he may; if not, he can come into the harbour and land it in lighters at the jetty and hoist it up. We do not allow timber to be landed in the harbour, because if logs get adrift they knock the boats to pieces; but if they like to put it in lighters and bring it to the pier, we hoist it up and take it in like any other cargo. The last witness must have made a mistake, because those two native vessels that he spoke of anchored here and got foul of the two piers. That was in the north-east monsoon; and they were not the only ones there. Then I wish to make another remark about what Sir George Nares was speaking of, namely, the outer breakwater that he proposed to cover the eastern opening. None of those ships can be relied upon to turn round very quickly, because many of them have their noses right out of the water, and it would require at least four ships' lengths to protect them from the present sea face.

2115. (*Admiral Sir George Nares.*) Would you say 2,000 feet?—Say 2,000 feet. The operation of carrying on this prolongation would be to shelter the opening, but the process of carrying it out would be analogous to the process of extending the north arm at the same time as the south arm was being continued. Whatever process you used to convey the blocks and rubble for this part would operate also in the other part.

2116. (*Chairman.*) The operation of carrying that rubble to the detached breakwater would be the same as would be required to carry out the protecting arm at the same time as the south pier?—Yes, it would double the work. Mr. Thorowgood's chief objection is the long time that it would take to do this.

2117. (*Admiral Sir George Nares.*) Have we got that in evidence?—I think you have a letter which I gave you the other day.

2118. We take it from you that that is as you understand it?—I understand, speaking as the representative of the Trust, that his chief objection to stopping this work now is throwing all those men out of employment, and the length of time that it would require to construct the northern and southern arm according to plan 3.

2119. For that reason you suppose Mr. Thorowgood is more in favour of plan 4 than of plan 3?—No, I have no reason at all to suppose so. His reason for preferring plan 4 is that he wants to keep all the people at work.

2120. Then you think that the only proposal that we have before us from Mr. Thorowgood is to keep the men employed by adopting plan 4?—Yes, that is his object, keeping the men employed; but the employment of the men must cease some day. A large number of men would be employed in taking up the broken remnants of the north entrance.

2121. (*Sir John Coode.*) You mean the débris of the outer portion of the northern arm?—Yes.

2122. (*Chairman.*) Will you consider this point: Supposing the entrance to the harbour to be made according to plan 3; that, it appears, would catch the north-east monsoon, and would have a tendency to fill up the harbour unless there is some outlet for it; and under the present circumstances it appears there is a current which always more or less accompanies the north-east monsoon, and would have a tendency to fill the harbour and keeps the level down the same as it is outside?—There is nothing that frees the harbour except when it overflows with water and the surplus finds its way out to sea.

2123. Under the surface, is it not?—We do not know anything about that. Close in shore there is what we call an undertow; but that is close in shore. Of course we all know the effect of an undertow in helping a ship when she is on a lee shore.

2124. There may be a difference of opinion about the way that the harbour frees itself and retains its level: do you think that it is by an under current or a surface current?—Hitherto the current that we observe as the cessation of the wall falling is a surface current, because it carries the boats out through the opening, but in short the undertow keeps the buoys out to seaward instead of rising and straining as they would do when the sea got straight upon them.

2125. The point which I wished to lead you up to was this: that if you could remove enough of the old wall and have sufficient depth of water for the purposes of navigation, do you think that that would be sufficient to relieve the harbour of surplus water?—I think the opening would be quite sufficient, because the water finds its own level.

2126. (*Sir John Coode.*) We hear of a strong current through the present entrance which extends below the barrier that would be left across the proposed entrance; what do you say to that?—Then if there was any current it would come in and go out.

2127. (*Chairman.*) You think it would make the circuit of the harbour?—Yes, when the water in the harbour got above the water outside there would be a deadlock, and nothing more could happen till the water forced its way out.

2128. (*Admiral Sir George Nares.*) If the bar were across the mouth of the harbour the under current would have greater difficulty in getting out, and it would have to rise to the surface and form more of a cross sea?—I do not think that there would be any sea in the harbour with the present entrance closed in. There would be no more sea in the harbour than there is in the Prince's Dock, Bombay.

2129. (*Sir John Coode.*) But the question is with regard to a barrier left on the site of the new entrance, the assumption being that all the rubble would not be removed quite to the bottom but only to a sufficient depth for the purposes of the navigation, which would be held to be about 30 feet. And if there is something like eight fathoms of water there it would leave something like 18 feet of barrier standing up above the bottom?—Yes.

2130. To my mind it is a very great question whether the pilot is not right in what he has told us with regard to the existence of this under-current under certain conditions, and that is the reason why the harbour retains its depth so well, because we are all agreed that there is no loss of depth in the harbour on a comparison of Mr. Thorowgood's soundings?—From 31 fathoms outwards it is so. All the accumulation is in shore.

2131. Then the question is whether that may not be due to the existence of an under-current sweeping the bed of the harbour; and if that be so, then to leave a barrier across the site of the new entrance might have a very prejudicial effect upon the harbour generally?—That is a technical question which you can answer better than I can, but all I know is that we cannot draw a comparison between an opening from side to side thoroughly exposed to the sea the whole breadth of the harbour, and one which would only occupy 500 or 600 feet on the north-east corner. I do not think that any current whatever would come in there. In the instance I gave the other day, the ship which I spoke of rode without her anchor down just in the place where we are canvassing the question of the current coming in, and did not move. If she had had any men on board her they could have hoisted the jib up and could have come in here (*pointing to the plan*).

2132. The pilot told us that in the north-east monsoon there is a considerable current coming down along there which strikes behind the north pier, or about the root of it, and then runs along seaward, and that that is a matter of very frequent occurrence; does that consist with your experience and observation?—The instance that I spoke of goes to disprove it.

2133. That particular instance; but do you not think that he is right in telling us, as he has told us, that during the north-east monsoon there is very commonly a current striking along from north to south and then along the back of the north pier, and would run across the site of the proposed north-eastern entrance if it were not influenced by a rebound from the extension of the sea face?—So far as I have had an opportunity of judging the way that the ships lie at their anchors; there are always native vessels lying about in this spot

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2134. That is lying about the pier all together?—Yes, but there appears to be a little whirlpool at some distance from the northern arm.

2135. Do you or do you not agree with the pilot that there is a current along the back of the north pier?—So long as the pier was being built there was, and it had a very injurious effect in undermining the rubble case.

2136. But do you think that the current has ceased there now?—I think that it has so far ceased that there is nothing to work upon now in this corner.

2137. Then if I understand you aright, you think that the very construction of the north arm has had the effect of baffling that current as it were and stopping it?—Yes, at present it has, at least I think so. The current rolls in a very curious way about this north-east arm, showing evidently that there are different currents.

2138. But the point which we are particularly concerned with is this: whether there is a current along the back of the north pier which might influence a vessel, attempting to enter the north-east entrance if such an attempt were to be made?—If I might say so I do not think it would have the slightest effect upon a vessel, but I have never noticed it.

2139. If there were a strong current it would take her in from the back of the north pier towards the head of the extended work at the northern end of the extension?—Yes.

2140. (*Admiral Sir George Nares.*) In the course of your last examination you gave us an account of a similar current to the one that we are talking about now at the south pier with a southerly monsoon, as affecting the discoloration of the water at the south-east corner outside the harbour; is there not a similar current to that on the north side of the harbour with a northerly monsoon?—Very probably there is; but there is no discoloration, because there is no sand on the north side. If the current operates on the north as it does on the south that affords another answer to this question about the current, because it shows that it would come from the north-east to the south-west.

2141. If there was a similar current on the north side to the one that you have told us about on the south side, it would set across the north-eastern entrance if it was open?—It would not go in; it would stretch across it in the same way, but no one can exactly tell the operation of a current.

2142. But it should not be ignored altogether in considering the question?—No, it should not be ignored, but we in Madras see no difficulties whatever about entrance or exit, either one or the other. The object that the Port Trust have in view is to get smooth water in the harbour, and it would be quite smooth if that part was closed according to plan No. 3.

2143. (*Sir John Coode.*) The pilot has told us that he would not consider the proposed entrance satisfactory unless there were an overlap of something like 800 feet to the northward of an imaginary line or an extension of the north pier; do you think that 800 feet would be too much or too little?—I think it would be a matter of experience as the work proceeded. So far as my experience goes an angle of 22 degrees, or about that, is all that I have ever seen waves strike the north wall or the shore anywhere along the coast. The moment you come into about 8 or 9 or 10 feet of water the tendency of the wave is to go straight on, and by the time it reaches the beach it is straight on to the shore, and about the mouth of the harbour I do not consider that it ever forms a greater angle than 22 degrees.

2144. (*Chairman.*) With the entrance to the harbour where it is now there is a considerable change of the water in the harbour, and there is more or less scour in the harbour; and if you close it and use the entrance to the north-east, protected from the swell by a covering arm, you would have less movement of the water in the harbour, would you not?—The currents always go north and south, there is no ebb or flow on to the shore.

2145. What I am coming to is this: do not you think that that would affect your harbour from a sanitary point of view?—No, certainly not, if that is the only place for the water to come in.

2146. Pardon me, on that side you are exposed to the full force of the swell which you say keeps the harbour in a disturbed state even to such an extent that there is always a surf on the beach, and you would close the harbour to that?—I would close the harbour from the swell.

2147. And therefore you would not have the same change of water?—But the swell does not carry anything on its surface. A boat will remain on the surface, and the swell will pass underneath it.

2148. (*Sir John Coode.*) The chairman's question had reference to the circulation of the water within the harbour; what have you to say to that?—We could easily find means of clearing the harbour out if it did not operate as at present. In bad weather when a certain quantity of water comes over the north arm, it causes an overflow in the harbour, and then wherever the opening is, the surface water finds its way out; but we should be in no worse position than any dock or anything of that kind in the world. They are all closed, and they all have to take their own method of cleansing.

2149. That is to say, if the sewage is turned into the harbour and becomes a nuisance, it must be diverted?—Yes, it must be diverted; at present they have under consideration the question of making a new intercepting sewer to take all the sewage away and prevent its falling into the harbour.

2150. (*Chairman.*) It is a question which you raised yourself; you spoke of the blowing sand, and the sewage forming a deposit which was gradually filling up the harbour, and I think you credited it with 100 feet a year during the last two years, did you not?—Two hundred feet during the last two years, but that of course could be removed, there is no question about that; the question of the drain being so far enlarged that the overflow will not go into the harbour is now under consideration, and I believe sanction was given to it; but there was some difficulty about it, as to whether the municipality or the Government, or the Port Trust, should pay for it.

2151. But you do not anticipate that that will influence the question of the harbour?—Not the least; I do not consider that it bears upon it at all.

2152. (*Sir John Coode.*) The pilot told us that he thought some not inconsiderable quantity of sand came through crevices in the work from the southward into the harbour; do you agree with that view?—It may have done so at some time or other, but at present it is level up. You can walk off the one on to the other.

2153. Then it would come over?—It would drift. I have heard it very often spoken of, but it must have been when the work was opened before the sand had reached so far as it now is.

2154. If on previous occasions it came through crevices near the shore, and the sand of the beach has advanced seaward, would it not continue to come through further out; have you noticed that?—I have never noticed it. Mr. Thorowgood only says that he thinks some sand does come through there, but that is a matter for his department. It is not a thing well known to us all. We have heard of it, and there may be something in it.

2155. But as to the blown sand; there is no question about that?—The blown sand of course you can see.

2156. Does it occur frequently that it can be seen?—It is only a few weeks in the year when we get what we call long shore winds, in March that it comes straight along the shore.

2157. Would that continue for many hours at a time?—About eight hours out of the 24, for six weeks with a dead long-shore wind.

2158. Is there much sand being carried by the wind on those occasions?—You cannot see it, but you can see the effects of it; you see a lump one day where there was none the day before, and things of that sort.

2159. (*Admiral Sir George Nares.*) The movement of the sand drifts, then, is not with the wind?—No; the sand drifts are all perfectly smooth on the surface.

2160. (*Sir John Coode.*) If it is not to be seen in the air but it is to be seen by its effects, you must conclude that it is conveyed along the surface and not blown into the air?—It is carried along the surface.

2161. It must be rather awkward if that beach continues to run seaward?—It seems to be stopped entirely now, but if it does it will only affect the eastern opening, it will not affect the north-eastern one.

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2162. With regard to that, do you think that an entrance from the north-east would be free from any question of allowing sand to accumulate within the harbour?—I think it would be perfectly free.

2163. Even if the sand at the southern end were to make a considerable advance seaward, you do not think even then that the proposed north entrance to the harbour would be affected, but you think that with the entrance where it was before it would be affected?—Yes.

2164. That you regard as one of the advantages of the north-east entrance?—One of the advantages.

2165. What would become of the sand, do you think?—What becomes of it now is this: it continues going round, and it is forming a bank on the south-east knuckle of the south pier. I see it in so many other places along the coast, that I cannot possibly blind myself to the fact that that operation is going on there just the same as it is 12 miles north.

2166. The conditions may not be all identical; there may be different conditions in this case which we do not know of?—It is difficult to know what they can be.

2167. We have no evidence from the soundings as yet that such a bank has grown up; you judge, I understand, from the discoloration of the water?—And from the sediment that I observe taken up in the water.

2168. But that may be passing along with the water and not necessarily settling down?—It settles down if it be taken up at the head of it, or behind it. I know that that is so.

2169. Did not you tell us that that appearance continued to something like a mile to the northward?—I forget what the distance is. I think I drew it on the plan.

2170. The pilot said it was about a mile?—I suppose that the pilot has never experimented on it as I have done.

2171. The pilot told us that he experienced currents across the harbour not uncommonly at the rate of three knots, but he did not think it was ever less than a knot and a half, and that that was continued for from 12 to 24 hours?—Three knots is an excessive motion. During the strength of the north-east monsoon with a strong wind from the north, or in the opposite condition, that is to say, a strong wind from the south, I should say that a current may more than two knots, or perhaps 2½ knots, is very extreme, supposing there is no cyclonic weather about, for then the current comes with a tremendous force.

2172. The pilot told us also that he looked upon the current, to use his own expression, as his biggest enemy; but that the current being got rid of he did not think much of the wind or the cross sea in entering; do you agree with that?—He knows what he suffers from. The ships coming to us always come straight in.

2173. You have not often gone outside, perhaps, you merely see it from the shore?—I see the current from the shore, and I have never heard it complained of; but if so, it would be much greater at the old opening than it would be at the new.

2174. Then he also told us that, assuming that this plan No. 3 were carried out as shown in the drawing before you, but with an overlap of 800 feet, he would consider that an entrance of 500 feet wide would be quite as good for the navigation as one 550 feet wide on the eastern face as at present, what do you say with regard to that?—I quite agree with him there, that it would be much better.

2175. Do you think that an entrance of less than 500 feet would be judicious?—No; I see no object in having it less.

2176. Then you would agree that 500 feet would be quite satisfactory?—Yes.

2177. (*Admiral Sir George Nares.*) That is to say, that an eastern entrance of 550 feet would have a cross current directly across the entrance, but the 500 feet entrance, at the north-eastern side, would have a more direct one?—I do not think that a north-east entrance would be affected by the current at all.

2178. (*Sir John Coode.*) He has seen the sea break as far out as eight fathoms, but never so far out as nine fathoms, does that agree with your opinion?—The sea never breaks at any of those distances except during cyclonic weather; it is difficult to say when the sea breaks, because there is always a lot of top water, and a mass of foam. The waves begin to curl, I have seen them, as far out as 10 fathoms, but at that time it is no question about going in or out because no ship could do it.

2179. But on all ordinary occasions he said the sea would never break further than about two thirds of the length of the north pier, is that about what you would say?—In ordinary weather it never breaks so far as that, it would be in about 3½ fathoms.

2180. But in rough weather which was not cyclonic, and with a strong north-eastern monsoon, how would it be?—It may break in about 5½ fathoms.

2181. (*Admiral Sir George Nares.*) You mentioned just now that an isolated breakwater to protect the eastern entrance if adopted would, if carried out further seaward, be obliged to be very considerably lengthened?—Yes.

2182. But a breakwater there would be a protection from the heavy easterly swell, would it not, rather than from the direct seas of the north-east monsoon?—Certainly, and so is the present contemplated breakwater.

2183. For instance, if one a certain length were placed 1,000 feet off the entrance, it need not be double the length if placed 2,000 feet off, because the sea would come direct in from the eastward?—I have seen a swell coming north-north-east sometimes. You might make the required breakwater, but it would cost an enormous sum of money, more than you could afford, and it would interfere with any future arrangements for increasing the harbour which the present line carried out parallel with the shore would give us.

2184. But if the question of expense is to be considered, have you entered into it thoroughly?—No, I have not.

2185. Then you cannot speak to that now as it would have to be in about 8 fathoms of water?—No, I cannot.

2186. Supposing that the harbour were completed and that the sand that had silted up to the southward of the south pier continued to increase to such an extent that the whole of the south pier would be silted up in say 20 to 25 years, would that affect your opinion as to the north-eastern entrance?—No. I answered that just now that it would leave the north-eastern entrance secure, but it would materially affect the other and the isolated breakwater. I do not know whether you have had before you the evidence of the breakwater committee. There were several very clever men employed upon it, and their opinion was that the moment the sand-laden water came to the edge of the breakwater proper, it would deposit itself. The objection to the breakwater was that in course of time it would silt up between the breakwater and the shore. I was not on that committee, it was before my time, but that was the evidence that was given in connexion with the breakwater; and if this sand is increasing there, as in fact we see, one is able to suppose that the same operation might go on there, but that is an engineering question.

2187. Supposing in this case that the south side of the pier silts up, then you would suppose that a shoal would form something like the Pulicat Shoals outside the breakwater altogether?—Yes.

2188. In fact it would form to some extent a protecting breakwater outside?—No, on the contrary, I think it would have a tendency to close the opening unless you made a great circuit round it.

2189. As I understood your evidence before, it was that in the case of shoals formed like the Pulicat Shoals a passage was kept open between them and the shore by the strong southerly current during the north-east monsoon—is not that the tendency off that coast?—Yes, at times the bank itself would extend across the eastern opening.

2190. But in the Pulicat Shoals there is a six-fathom passage between the shoal and the shore?—About a five-fathom passage.

2191. Would not the north-east monsoon tend to keep the opening free between the present harbour and any isolated breakwater put down to the seaward of it?—It probably might, but the Pulicat passage is a very narrow one; too narrow for ships to come in. They have to turn round the bank and come in through the eastern opening. I passed through it the other day in a large British India steamer, and we found nothing more than five fathoms. I should think the whole width is much less than a quarter of a mile.

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2192. My question was more particularly as to the tendency of the sand to deposit on the coast, in the manner you alluded to in the case of the Pulicat Shoals?—The tendency in my opinion is that all obstructions and interference with the harbour in the shape of sands come from the south.

2193. If the sand were to grow out to the end of the breakwater it would tend then to pass the wall of the harbour and gradually silt up the north end, would it not?—No, I do not agree with that. In all the cases that I have mentioned it goes to the north-east.

2194. Then you think it would still leave the proposed north-east entrance clear?—Yes, I think it would be always clear. But this is mere conjecture. Whatever danger may come to the harbour in the way of obstruction opposite to the entrance, in my opinion and the opinion of the Port Trust, comes from the south sea, and consequently we want to avoid that by having an opening to the north.

2195. (*Chairman.*) Do you feel any confidence in the stability of the works when they are re-constructed to withstand such a typhoon as you say you had in May last year?—Yes, I think that they would stand that. It was nothing at all compared to what we have had to experience.

2196. And stand the most severe cyclones?—My only want of confidence is in the upright wall, not in the mass. I think if there is any subsidence on the inside and the upright wall once departs from the perpendicular, the constant shaking of those 30-ton blocks from the outside, owing to the force of the sea, might have the effect of tumbling over the inside wall and causing great mischief.

2197. Would you prefer to see both sides alike, both the inside and the outside, the support from the inside being angular inside of perpendicular?—I think so.

2198. (*Sir John Coode.*) Do you mean the substructure of the work should be composed entirely of pell-mell blocks with a cap of concrete on the top to carry the titans?—Yes. Of course in 12 feet you could always level the top with concrete, because there are several months in the year when there is no possibility of any wet coming in. You might lay it in bags or make it in blocks on the spot. The thing looks very strong now, but the mistrust that we and that many other people have, is of the upright wall on a sandy bottom with mud here and there.

2199. There ought to be a good and sufficient rubble base on the original bottom and the upright wall built up from that, from 18 feet below the water?—I do not think there is any bottom that is to be relied upon. As I say, that breakwater of Sir Arthur Cotton's has altogether sunk in 21 feet of water, and has utterly subsided.

2200. But we do not know what the section of that was?—No, but it could be got from the Public Works Department. This wave-breaker outside is of course a very valuable assistance. Our idea was that a similar support should be given to the inside; but that is an engineering matter upon which we have no right to say anything.

2201. You think that the support required was from the inside?—From both sides.

2202. (*Chairman.*) Do not you think that the wave-breaker outside was not sufficient to protect the wall from the sea?—I do not put it in that light exactly. It is the bottom that I attribute danger to the walls to, not the top. I fear that there would be some subsidence from the treacherous nature of the bottom and the loose quality of the rubble, so that if the wall once departed from the perpendicular, in my opinion, it would only be a question of one or two rough days before it would tumble in; but we should then have a solid base on which to build pell-mell blocks.

2203. (*Sir John Coode.*) Here are three sketches of the harbour according to the different designs (*handing the same to the witness*) which we have had prepared, and which we placed before the pilot in order that he might give us an idea of what in each case should be the clear water space that would be left when vessels were moored in the harbour; No. 1 is the Madras harbour as it existed before the cyclone of November 1881, No. 2 is Mr. Thorowgood's design, and the yellow one, No. 3, is the one which met with the approval of the Harbour Trust. I should say that the pilot disapproves altogether of No. 2. He has marked in pencil on No. 1 the area of clear water space that he thinks ought to be allowed, he does not care to look at No. 2; but in the case of No. 3 he has there marked also the clear water space, which he makes, that there should be at least 800 feet of overlap, could you give us any opinion upon that point?—I think that is a question for the engineer to give an opinion upon.

2204. It is a question of being able to get in?—I do not suppose that he ever made any inquiry into this.

2205. He said that there should be a clear length of a ship and a half; do you agree that the clear length of a ship and a half overlap would not be too much?—Not a bit too much.

2206. Do you agree that these pencil lines on the sketch would indicate the water space?—Not quite. At present about six berths are appropriated in the breadth of the harbour in water varying from 4½ to 5½ fathoms with the ships' anchors and chains in the bows and their heads pointing to the eastward, seaward, and their sterns confined to a buoy by a single line. Then if the southernmost berth, which we will call No. 1, is the only one vacant, it stands to reason that the pilot, instead of coming in, as he has described, has to sweep round into the south-eastern portion of the harbour in order to reach that berth and avoid any interference with the anchors of other ships. We give them about 20 fathoms of cable each. In the north-east monsoon we put an additional small vessel under the lee of the north pier, and in the south-west monsoon another vessel in a similar position under the lee of the south pier. We cannot get room for more than seven, but we want at least 12.

2207. Then in fact that harbour would not accommodate all that you want?—I think it would not. We have an eastern opening,—I am talking of the thing as it exists now. If we can treat it as a dock we can work our ships into their places, but as it is now we are obliged to treat it as a seaway.

2208. (*Chairman.*) No matter where you have entered you must give ships swinging berths, because when squalls come off the land you have to ease up their stern hawsers?—They are all eased together. They all take a little turn together. There is only just one season in the year, in the months of June and July, when we get squalls off the land, and then they just ease their hawsers a little bit.

2209. (*Admiral Sir George Nares.*) With squalls off the land they do not swing round all together?—No, they never do.

2210. Because the pilot rather led us to suppose that they let go the stern hawser and swing right round?—They never do that. The hawsers sometimes part, but they never go beyond that angle.

2211. (*Chairman.*) The pilot was speaking then of squalls which prevailed at certain times of the year from the north-west?—That is at the commencement of the north-eastern moonson, but I suppose there would not be two a year.

2212. He said there were two a week?—I do not agree with him. I could give you the weather for every day of last year if you wish it.

2213. (*Sir John Coode.*) To put it shortly, with the harbour as originally designed, and as it stood before the cyclone of November 1881, you could moor how many ships with safety?—None with safety.

2214. With the harbour constructed according to the yellow design, No 3, how many could you move with safety?—We could treat it as a dock. We should be able to have very strong bollards placed there which we never had before, to help the ships, because otherwise a ship would pull the whole thing overboard. As for any bollards or anything of that sort we never had them, but with the new construction we could get bollards to each ship that lies alongside near the pier, and they could lie there with their sterns fastened securely to the bollards.

2215. How many more ships do you think could be put into the harbour according to the yellow design?—I should say that we could accommodate 12 easily. We should be able to put down regular buoys (not temporary buoys like Mr. Parkes') and make the ships' sterns fast to the bollards. We could treat it as a dock in fact, and manipulate the ships in a way that we cannot do now.

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2216. In fact, according to your opinion, you could put something like twice the number of vessels in No. 3 that you could in No. 1?—Yes, there or thereabouts, because we could warp the ships in.

2217. (*Chairman.*) I think you said you could give us statistics of the weather for the year; have you them with you?—I have not them in England. Every day my deputy puts down the state of the weather and the state of the sea in the harbour. Very constantly accidents happen to cargoes, and the owners and consignees are constantly saying, "It is a peril of the sea," and people who want to make a claim come and ask me what the weather was on such and such a day, and I refer to the list and tell them, and if the weather was fine I say: "You had better resist any claim that may be made."

2218. If there was a squall in the course of a night, would that be put down?—No, not in the night, the observatory returns only give you the number of miles in a day for the wind, but in the case of squalls that come off the land, they are very much sheltered by the houses and lofty buildings along there; the whole way along the beach there are lofty buildings 50 or 60 feet high; in fact it is impossible to imagine a finer place and an easier place for ships than Madras. Except during the short interval of cyclonic weather it is all fine weather.

2219. (*Sir John Coode.*) In short you would regard the harbour in design No. 3 as one of a totally different character from what I may call the original design?—Yes, I should be satisfied with No. 3, and so would all the Madras public be satisfied with No. 3, leaving the extent of overlap as a matter of experience. The first rough weather would show how far it requires to go.

2220. Still it is possible that it might go so far as to make it very inconvenient to get in?—But as I say, the water here is always clean and clear, and it could never have any bad effect upon vessels coming in.

2221. The pilot told us that he had known occasions when that current existed along in front of the harbour for three or four days occasionally to such an extent as to make it difficult to take ships in?—I think that might be quite possible, but he never drew my attention to it. In cyclonic weather, when there is a storm in the bay, the water gets heaped up at the end of the bay and comes down with great force.

2222. General Sankey told us that during a cyclone the disturbance on the shore had been so great as to claw away the whole of the sand on the beach and to leave a vertical face of something like four, five, or six feet standing up; have you ever seen that?—I have seen it just a short time when surf was breaking, but that is the time when the boats get wrecked.

2223. But the point is this, whether to that circumstance is not due in a very great measure the disturbed state of the sea which we have heard of in the inner part of the harbour, because naturally there would be more surface disturbance caused if there were a vertical face than if there were a sloping beach?—Yes, but the first fine day you see nothing more of it, it only exists for a day. The sand is so movable that it restores itself in one night or one day.

2224. Still it may be in some degree the cause of the very disturbed state of the sea within the harbour?—Something must stop the sea, and that does it—it cannot go up beyond the line of houses.

2225. But there would be a rebound from that vertical face which there would not be from a sloping beach?—No, the sloping beach makes itself into a vertical face.

2226. As long as it continues a vertical face there would be a rebound from it, and you get the jobbly sea that we have heard of?—The Masoolah boatmen say that the wobble inside the harbour is worse than their fathers used to experience when there was no harbour there, but that is to be obviated by the smooth water which will ensue from the eastern opening being closed. The boats get dashed to pieces now; they cannot get out.

2227. I suppose you would say that the principal part of the damage was done before the works began to collapse?—Every bit of the damage was done before the sea face of the breakwater began to subside. I told the Governor, Mr. Grant Duff, on whom I called after breakfast and saw, that everything was destroyed on the beach. Nearly all the boat craft that lay there were destroyed, but at the time I saw no sign of any alteration of the sea wall. It appeared to me to be standing firm; but as I went down the beach I saw it subside very distinctly. At that time the wind was off the shore, and to all appearance the weather was cleared up.

2228. (*Chairman.*) With regard to those ships that unload outside on the north side of the harbour, ships unloading railway iron and coals and so on, have you to send them to sea at times when you could not send a ship to sea out of the harbour?—No, it never has occurred yet, in fact the harbour is the least safe of the two, because there is the danger of collision. When over bad weather is coming on I send circulars round to all the ships in the bay, to the captains or the chief officers, saying that in my opinion they are better outside; but if they choose to remain the better way would be to get their steam up and make their arrangements accordingly. Then as to ships outside, in a bad weather season, they are all sent away; both native ships and European ships are obliged to anchor in 10 fathoms of water clear of everything.

2229. I presume that the bad weather season means specially during the month of November?—Yes, November and December.

2230. You do not allow them to anchor there and discharge at all times?—A steamer may do so if she gives me to understand that she is quite aware that she is doing it at her own risk.

2231. And they do so?—They do, perhaps only a part of a day or so. We have had sometimes ships landing coal all through the bad season and landing railway iron and bars, but the moment they see anything in the weather to justify the fear of a surprise then they go away.

2232. Are they more liable to surprise than ships inside?—No, not a bit, in fact they can go at any moment, night or day; but ships inside cannot go when they like through this opening (*pointing to the plan*).

2233. (*Sir John Coode.*) They could get out better at night through the north-east opening than they could through the existing opening—the old opening?—The old opening is opened without lights now.

2234. If it were made so, they could get out I apprehend more easily than they could through the north-eastern opening?—No, I think not.

2235. It is a more direct line?—No, not to ships lying here (*pointing to the plan*).

2236. (*Chairman.*) What advantage do they gain by discharging outside?—Because that is done at particular landing places by the Madras Railway Company and the timber merchants only. Other parties are allowed to land timber a mile and a half north. The only place where the railway company land is that little bay close to the north arm. They pay harbour dues, but they avoid carriage from the outside to the inside, and save a little in that way.

2237. They pay the same harbour dues as vessels going into the harbour?—Yes, just the same.

The witness withdrew.

Adjourned.

At the Board of Trade, Whitehall.

Friday, 24th June 1887.

PRESENT:

VICE-ADMIRAL SIR NOWELL SALMON, V.C., K.C.B., IN THE CHAIR.

SIR JOHN COODE, K.C.M.G.

REAR-ADMIRAL SIR GEORGE NARES, K.C.B.

MR. F. C. THOMPSON [India Office], *Secretary*.

Staff-Commander FREDERICK HIRE, R.N., examined.

Staff-Com. F. Hire, R.N.

24 June 1887.

2238. (*Chairman.*) You were, I believe, navigating officer of Sir William Hewitt's flagship, the "Eurydalus"?—Yes.

2239. And you visited Madras twice?—Yes.

2240. In what years?—In March 1883 and in February 1885.

2241. You had never seen it in its complete state, I believe?—No.

2242. Did you get any benefit from the harbour as it was while you were there as compared with lying out in the roads?—I think it was as smooth outside as it was in the harbour. I may say that I was there in the third week in February and the third week in March.

2243. (*Admiral Sir George Nares.*) Would that be during the north-east monsoon?—Yes. There was no wind at all; the wind was light from the southward when I was there; it was south and south-east, but scarcely any wind at all to speak of.

2244. (*Chairman.*) But it was during the north-east monsoon time?—Yes, it was during that time.

2245. Did you remark any current?—No, very little. There was very little current coming down near the shore; but I did not seem to feel any current running.

2246. Did you take the ship into the harbour yourself?—No, a man from the harbour master's office came out and took her in.

2247. (*Sir John Coode.*) Where did she lie at the time?—Upon our chart the buoys are not marked; but it was just on the south side of the opening, about midway from the shore, and rather on the south side.

2248. (*Chairman.*) Did you lie at your own anchors?—No, we lay at a buoy with a wire hawser at the stern to another buoy; we lay along two buoys.

2249. (*Sir John Coode.*) Were you there a long time?—Two days on each occasion.

2250. (*Admiral Sir George Nares.*) With the ship's head pointing which way?—To seaward.

2251. (*Chairman.*) Was there any swell at all setting in through the entrance?—Very slight indeed. On the beach within the harbour the surf was very little; the smallest boat might have landed on the beach inside the harbour.

2252. (*Sir John Coode.*) Did that swell on the beach in the harbour differ from that on the beach outside?—There was less swell in the harbour than there was on the beach outside; but there was very little surf on the beach outside the harbour north and south.

2253. Did you take sufficient notice to enable you to say that there was a difference between the two?—Yes, certainly.

2254. The swell was directly on shore, I suppose?—Yes, the swell was directly on shore.

2255. (*Chairman.*) The question before the Committee is as to the position of the entrance in the re-constructed harbour works; do you think that there would be any objection to making the entrance, supposing it to be left in the same position as it is now, 100 feet narrower?—I should think there would be no objection at all.

2256. You would have no hesitation in taking a ship through, supposing her to be anywhere about where in fact they do take ships in?—None whatever.

2257. The swell would be right behind you, would it not?—Yes, of course, always providing that those arms were built up so that you could recognise the finish of them, not rough so that there should be any doubt as to where they ended.

2258. (*Sir John Coode.*) The supposition is that when reconstructed the works which were six feet above sea level before are now to be twelve?—I understand so.

2259. (*Chairman.*) Will you look at the plan on the table before you which shows the proposed entrance to the north-east, and will you just carry in your mind the north-east trades as blowing pretty fresh with a sea broadside end with no large tail; and if you can carry in your mind the space inside the harbour fairly well, will you tell us if you would have any objection to take your ship in through such an entrance as that. Of course I may say that there is no limit to the covering arm, the covering arm may be made as long as is necessary?—I do not see any difficulty or danger in taking in a vessel through the opening in the north-east monsoon.

2260. (*Sir John Coode.*) That opening being 500 feet wide?—Yes. I should not think there would be any danger whatever. Our ships do go in now and then; they nearly all have steam steering gear, and even without that the steering appliances are very good and powerful.

2261. (*Chairman.*) You would not be afraid of keeping up the necessary speed to keep your ship under control when running into a harbour of that size?—None whatever.

2262. You would be able to bring her up?—Yes, I should have no difficulty whatever, certainly not, with 500 feet across.

2263. (*Sir John Coode.*) The overlap, as you see it indicated on this drawing, is about 500 feet. Would you suggest any objection to that; what would you say with regard to that amount of overlap, do you think it is too much or too little, or do you think it is right?—It looks to me to be of a very suitable length to shelter the ships coming into the pier within the harbour.

2264. Speaking broadly, what would be the difference as between two entrances, one where it now is on the eastern face, and another at the north-east corner, so far as navigating a ship goes, irrespective of the smoothness of the water inside, which would you prefer?—I think the north-east opening would be the easiest for entrance and exit.

2265. It has been suggested to us that the overlap might with advantage be made 800 feet, what would you say to that proposal?—There would be no objection whatever to it so far as I can see, the vessel would be sheltered by the arm.

2266. Do you think that 800 feet would be better or worse, or that it would give no advantage over 500 feet?—I think an extension beyond 500 feet would be advantageous.

2267. Obviously it would give more shelter within the harbour in the north-east monsoon?—It would give a vessel smoother water in passing through the entrance, and I think it would give a vessel a feeling of safety being in smoother water.

2268. And obviously, as I said just now, it would afford more shelter within the harbour itself in the north-east monsoon?—Yes.

2269. Was it as smooth as you spoke of just now on both occasions when you were at Madras?—On both occasions the water was perfectly smooth, as smooth as this table, there was the least little swell in the world, which expended itself on the beach.

2270. Did you land often when you were there?—I landed twice at the pier during each visit.

2271. I suppose that was at the outer end of the pier?—Near the outer end.

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2272. Then you had an opportunity of noticing the swell on the beach?—Yes.

2273. We have been told that with scarcely ever an exception there is a very heavy and inconvenient swell upon this beach, although it may be smooth outside?—It was not so when I was there.

2274. (*Chairman.*) You think that you could have landed always in boats on the beach?—Yes, certainly, anywhere, without any trouble in the world; I could have landed in a dingky.

2275. (*Admiral Sir George Nares.*) Was the weather exceptionally good when you were there?—I should think it was exceptionally fine.

2276. And you expected to see different weather?—Yes, I expected to see different weather. I expected certainly to see more surf all along the beach, and I was surprised to see so little.

2277. You have had no experience yourself of conducting a ship under similar circumstances to a vessel which would have to approach the harbour with the north-east wind, which would be with the rollers abeam, in seven fathoms of water?—No, none. Of course the harbour and the beach present a very different appearance in bad weather to what they do in smooth weather.

2278. With the entrance in the old position and the eastern entrance reduced from 750 to 450 feet, would there be a difficulty in taking a vessel in, do you think if there was a side current of two knots and sometimes three knots an hour?—I should say not.

2279. You have mentioned that when you went in there was no side current; we have been informed that the usual current in the north-east monsoon with an ebb tide often runs from two to three knots, would that make any difference in entering an opening of 450 feet with a long ship?—I should say so, certainly.

2280. Under those circumstances would you say that 450 feet was too little?—I should think 450 feet would be sufficient if people are aware of the current running.

2281. Did any of the "Euryalus" boats land on the beach on those occasions?—No, they did not that I know of, as they had the pier to land at with ease.

The witness withdrew.

Capt. W. H. S. Latil.

Captain WILLIAM HENRY SINCLAIR LATIL examined.

2282. (*Chairman.*) Are you in command of a ship under the British India Company?—Yes, I have been in command of a dozen steamers.

2283. What vessel are you now in command of?—I am now at home on leave.

2284. This Committee is appointed to give an opinion as to whether it is desirable to alter the position of the entrance to Madras harbour which is now being reconstructed, and especially having reference to nautical opinion upon the subject. You have been pretty frequently in and out of the harbour, I presume?—Yes, hundreds of times.

2285. Have you been in the habit of taking your own ship in and out or has that always been done by a pilot?—Since the completion of the harbour it has always been done by a pilot; as soon as a pilot was appointed.

2286. One of the suggestions which have been made is that the entrance to the harbour should be left in its present position, but narrowed by 100 feet, that is to say, reduced to 450 feet; do you see any objection to that reduction?—I should think it would be useless, and that nothing whatever would be gained by it.

2287. In what respect?—The sea would roll in with as much force if the entrance was narrowed 100 feet as it does at present.

2288. Then you think that an opening on the east face is objectionable, no matter what the width of it is?—Decidedly objectionable, no matter what its width may be.

2289. Have you often been obliged to remain outside in the roads in consequence of the weather being too rough to admit of your going in?—Frequently. I have frequently gone in and then gone out again on account of threatening weather. I have gone in perhaps for an hour or so, and come out again.

2290. Were you familiar with the harbour when it was at its best and before it was partially destroyed by the cyclone of November 1881?—Yes, I was.

2291. Did you gain much advantage from it, as it was then, in the matter of loading and unloading?—In my opinion, decidedly not.

2292. Do you think that it could be improved?—I do, but never for it to be a harbour of refuge.

2293. But for the purposes of loading and unloading, what should you say?—Yes, it could be improved for that.

2294. On the table before you there is a proposal for an opening at the north-east corner, does that commend itself to you as being an improvement upon the present entrance to the eastward?—Yes, that is an improvement, certainly.

2295. Should you consider it any objection to the handling of long ships and taking them in by that entrance; do you think it would be as easy an entrance as the other to take a long ship in?—No, certainly not as easy as the other.

2296. Do you think that the additional difficulty would be a sufficient objection to it to condemn it?—I have been thinking of that a good deal, and it could be done, certainly. There is an advantage in an opening at the north-east corner.

2297. You mean that it would be an advantage to the harbour?—Yes, it would facilitate the work very greatly.

2298. Of course there is no limit as yet put upon the extension of the arm. That would, I presume, be a matter of experience?—Yes, I should say so.

2299. So that in carrying it out you must of course remember that you are not limited to only 500 feet of projecting arm, the entrance itself being also 500 feet.—My objection to that plan is that in the previous cyclones it was precisely these corners that were overturned, and they are putting a second row of blocks of stone now, I believe; that is just the crucial point, whether or not that would be sufficient. Those two arms were intact at the last cyclone; it was a seaward face that was destroyed.

2300. Have you formed any clear idea as to a means by which the harbour could be improved?—I favoured in my own idea two alternatives; I favoured an entrance considerably past this debris of the previous wreck; inshorewards of it, or else another groyne run out north and south some distance beyond the present site.

2301. (*Admiral Sir George Nares.*) Do you mean a detached breakwater?—Yes, a detached breakwater, like it is at Plymouth.

2302. (*Sir John Coode.*) For the protection of the entrance on the east face?—Yes.

2303. (*Admiral Sir George Nares.*) That is purely a nautical opinion; the question of expense being put on one side?—Yes, exactly so. That, of course, is the objection in my mind, that such a very large outlay would be involved.

2304. But if a detached breakwater could be provided for the same sum as would be expended on opening the north-east entrance, you would prefer a detached breakwater outside the eastern entrance?—Undoubtedly; but to overlap the two corners.

2305. (*Sir John Coode.*) How far seaward would you put it?—There again the difficulty comes in with regard to handling your steamer; it would have to be double that length.

2306. (*Admiral Sir George Nares.*) At least 2,000 feet?—Yes, quite, with a long steamer.

2307. The present harbour being 3,000 feet from the shore to the entrance?—Yes, quite.

2308. (*Chairman.*) Have you made any observations at all, upon the advance of the sand?—I have. There is considerably less water at the extremity of the pier now than there was 10 years ago.

2309. (*Sir John Coode.*) Have you ascertained that by sounding?—No, not by sounding, but by the break of the sea and by my eye; and also by observations of the pier-masters and other officials of the harbour. It is a well-known thing, although I never actually measured it myself, that there is less water there.

2310. Less water along the sea face of the work?—Along the pier for landing cargoes within the harbour and at the jetty, and, in fact, it is well known that erosion is taking place very largely along this north face, and that the south side is filling up fast.

Capt. W. H. S. Latil. 24 June 1887.

2311. (*Chairman.*) Might you not anticipate that if you put a covering breakwater outside the present harbour, the sand in motion would very soon deposit there between the two works?—I do not think so, there is so strong a scour of the current that in my opinion it would not silt up.

2312. From which direction does the strongest current come?—From the northward.

2312a. From which direction does the sand come?—I cannot tell you that.

2313. Is it not with the south-west monsoon that the sand is deposited when there is practically no current, or but little current?—I have not made any observations upon that point; but I should think that it would be so, certainly. I have not observed the deposit of sand more in the south-west monsoon except in the course of the construction of the breakwater, and then I remarked the sand collecting very rapidly on the southern groyne as it was built, and that the sand went out very rapidly. I observed it from the time when the first stone was laid almost; I was there a week at a time.

2314. (*Chairman.*) You have expressed the opinion that the harbour can never be made a harbour of refuge; do you think that it presents sufficient advantages over the roadstead to lay out any very considerable sum of money in additional works?—Having gone so far now, I should say it was a pity not to complete it.

2315. I mean additional works, such as a breakwater?—I should say so.

2316. From what you say of the silting up inside the harbour, it would rather appear that any wharfage erected in a line with the beach would very rapidly become useless from the deposit of sand?—Yes, certainly, as a matter of fact you can see it yourself, and anyone who goes there even occasionally can see how the sand has increased and extended even in the area of the harbour.

2317. (*Admiral Sir George Nares.*) Is the sand in motion by the wind on the south side of the harbour on the reclaimed ground; does it blow over into the harbour in any way?—No, I do not think so.

2318. You cannot see any sand cloud?—No, I should not say that.

2319. (*Chairman.*) Is the state of the harbour there very insanitary at present?—I do not know, I know there are many more sharks than there were formerly—there are swarms of sharks. I do not know that is it more unhealthy than it was before. There is always a sea breeze to carry off any smell; but with an ordinary sea breeze, when this harbour was complete and intact on the old scale, there was more jobble of the sea inside the harbour than there would be in the outer roads with an ordinary sea breeze blowing in.

2320. That is, in fact, during the finest part of the year?—Yes, exactly so.

2321. I think, from what you have said, we may assume that, even supposing an entrance were opened to the north-east, and the eastern arm closed, and the wall built up 6 feet higher than it was before, that is to say, 12 feet above the sea level instead of six, even then you would not think it a safe harbour in which to ride out a cyclone?—Most certainly not.

2322. (*Sir John Coode.*) Would you, if there was a detached breakwater in front?—I cannot speak from experience, I should have to be governed by experience there. If I was at anchor and a cyclone blowing, I should go out to sea.

2323. Do you think that it could be made a harbour of refuge by any means?—No, I do not, on account of the nature of the bottom; it is not good holding ground.

2324. Is it such that moorings could not be put down to hold the ships?—We bring our stern moorings home frequently.

2325. Do you think that in all respects it is as effective as it could be made?—That I cannot say.

2326. Supposing that the moorings were made effectual?—I should feel more confidence, certainly, then.

2327. This jobble of the sea that you spoke of has been described to us by two or three other witnesses, as well as yourself; does that jobble render it more or less inconvenient to land and discharge goods than if you were outside in the roadstead?—Yes, more inconvenient, certainly.

2328. Then the only advantage that you derived was by the nearness of the ship to the shore?—Yes, as it was then.

2329. Are any goods lost overboard from this agitated sea outside?—Frequently lighters lose goods out of the slings.

2330. Has that happened more than once?—Yes, frequently.

2331. Do you think that that would still occur if the opening were retained at 500 feet, and the works carried up to 12 feet above the sea level all round; do you think that that would still happen?—No, I do not.

2332. That is to say, the works restored upon the original plan, but made 12 feet above the sea level instead of 6 feet, and with the same opening?—No, the opening is the weak point in the whole matter.

2333. Then I gather from your answer that you think it is essential to close that old opening at the eastern entrance?—Yes, I do; I do not approve of that opening.

2334. Further, you do not think that the harbour ever could be made satisfactory whilst that opening exists?—Exactly so.

2335. But you think that it could if the entrance were to the north-east?—I should prefer the detached breakwater.

2336. The detached breakwater which you described to us just now extending from knuckle to knuckle would be 3,000 feet, that would make a detached breakwater in extent equal to the whole length of the sea face?—No, I mean that in case there was a detached breakwater the original entrance could remain.

2337. (*Admiral Sir George Nares.*) I think you said covering each end of the present opening?—Overlapping them.

2338. (*Sir John Coode.*) How much overlap would you have at each end of the present opening?—I would say, half the round.

2339. That is to say, half the length of the present eastern face?—Yes.

2340. (*Admiral Sir George Nares.*) About 1,500 feet?—Yes.

2341. (*Sir John Coode.*) With regard to this overlapping of 500 feet as the proposed north-east entrance, do you think that that would suffice, or would you like to see it longer, always having regard to getting a vessel in and out?—I do not think that much would be gained by extending it any further.

2342. It is obvious, of course, that that would give more shelter within the harbour; but the question is how would it affect the getting of vessels in and out?—Yes, that would be the difficulty.

2343. It has been said that that might be made a matter of experience, if it required extending, and that there would be nothing required to be undone?—Quite so.

2344. Have you given a great deal of consideration to this question?—Yes, in fact, it is a common topic amongst us master mariners in the merchant service, in the British India Company particularly, as we have so much to do with the port. I happened to be on that particular station, between Burmah and Madras, for many years, and I saw a very large portion of the harbour laid down.

2345. Then you have seen it under all conditions of sea and weather?—Yes.

2346. We have been told that the sea comes in almost invariably directly on to the shore and that the greatest amount of variation is never more than 30 degrees from a right angle, does that consist with your experience?—Yes, it does.

2347. (*Admiral Sir George Nares.*) The course to Calcutta would be about north-east, would it not, from Madras?—Yes, about north-east.

2348. The course south towards Ceylon would, immediately you left the harbour, expose you to beam rollers, would it not?—Precisely so.

2349. Is it the custom to turn a vessel on to her course at once or to make an offing to get the rollers a

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little abeam?—With experienced men we invariably make an offing of the coast for a certain distance under any circumstances.

2350. The great drawback to the north-east opening would be that it would expose a vessel entering and leaving to beam rollers, would it not?—Yes.

2351. More than an eastern entrance?—Yes.

2352. And it would expose them in a depth of water of 6¼ or 7 fathoms?—Yes.

2353. Would you think that an objection if it could be guarded against?—Yes.

2354. But if it could not be guarded against, still vessels could go in and out of the harbour for commercial facilities?—Yes.

2355. Then your evidence goes to show that in some way or other to render the harbour efficient, commercially, the water inside must be quieted?—Precisely so.

2356. Other captains of ships have told us that the sea inside the harbour with the north-east monsoon was practically quieter underneath the north-east elbow when it was in its old state; do you think, even supposing it is completed again under the new scheme and raised and the walls considerably strengthened, there would be quiet water under that north-east arm in the north-east monsoon. I am not talking about cyclonic weather, but ordinary monsoon weather?—Yes, I think so; my experience is that you can get smooth water in the north-east angle of the harbour, and better water than anywhere else.

2357. But that on the south-east side there was a considerable lop of the sea and sufficient to disturb the lighters alongside the ships?—Precisely so. The north-east corner was always the favourite anchorage if we could get it.

2358. Have you visited Pulicat or Armaghan?—No, I have not visited either of those ports.

2359. But the chart would show that with those off-lying shoals, the scour with a north-east monsoon is sufficient to keep a 5 or 6 fathom channel between the shoal and the shore?—Just so; I have studied that pretty often.

2360. Without committing yourself to an engineering question, you would suppose that with a covering breakwater nature would keep a channel through much in the same way?—That is certainly my opinion. I should not fear the channel silting up at all.

2361. When you say that the harbour would never be a harbour of refuge, you mean that you think it will never be a harbour of refuge for your large ships of 400 or 500 feet long?—Yes, I do.

2362. You do not mean to cut it out from small craft. Supposing the water could be quieted for you in cyclonic weather, it would shelter a number of small vessels?—Yes, certainly.

2363. But with the present eastern entrance in cyclonic weather there is no shelter whatever for anything?—None.

2364. (*Chairman.*) Does the state of the weather at Madras make any difference to your business, that is to say, do you avoid Madras at certain times of the year to any extent?—There are certain times when we take more cargo than at others. Just before the break of the monsoon we take large cargoes of rice; there is a large amount of rice inmoored into Madras, and that is more at one time of the year than another; various causes affect it.

2365. (*Sir John Coode.*) That is rather on account of the course of trade?—Yes, it is on account of the course of trade.

2366. (*Chairman.*) Then it makes no difference whether it is the north-east monsoon or the south-west monsoon when you are going to Madras?—No difference; the difference consists with us master mariners personally in keeping a very sharp look-out for the weather from October to the middle of December.

2367. Still that being the bad weather season would not affect the ordinary course of trade?—No.

2368. (*Sir John Coode*) Although you do not carry the mails, as I understand, you go practically at stated periods?—Yes, certainly. It is only within the last two or three years that we have ceased to carry the mails on the coast.

2369. What is the largest ship that you have ever taken into Madras?—The "Nerbudda," 4,000 tons.

2370. Have you taken her in very often?—No, not very often, I was not with her very long; but I have often taken in other large steamers of 3,000 or 4,000 tons.

2371. (*Chairman.*) And you would not hesitate with such a ship to run in pretty close to the line of surf before you could turn to go into the north-eastern entrance?—I should have no fear in commanding a vessel of the class that I do command, because I can rely on the engines; but there are in my opinion many steamers where they could not be relied upon, and it might be dangerous.

2372. (*Admiral Sir George Nares.*) You mean some of those cargo vessels with their bow out of the water?—Exactly.

2373. (*Sir John Coode.*) Is there much surf on the beach within the harbour as a rule?—Yes, it is exceptional when there is not a surf on the beach within the harbour.

2374. In fact, so far as we can gather from the evidence given us, it is rarely that you can land in the shore boat on the beach within the harbour?—Hardly ever.

2375. I ask the question because we have had evidence given to us this morning by a commander who has been there on two occasions only, and he tells us that on both occasions he could have landed in an ordinary boat, a dinghy, I think he said?—It is ridiculous.

2376. You mean to say that it must have been very exceptional?—Very exceptional; he might have fancied it; but if he had been in a boat I would guarantee that he would have been very sorry to have been there.

2377. Over how many years does your experience of Madras extend?—Fourteen years as commander, in all 20 years.

2378. Over that time, what would you say was the average number of times per annum you have been at Madras, roughly?—Twice a month over 20 years; I have been on that coasting line for many years; I was six or seven years between those two ports, Madras and Rangoon, a week at Madras and a week at Rangoon and a week at sea.

2379. (*Admiral Sir George Nares.*) Could you give us an idea of the amount of yawing that you would expect in a well freighted steamer taking a north-east entrance with ordinary north-east monsoon rollers, would it be as much as a point each way?—No, I should say that it would be less with an ordinary steamer.

2380. In turning in, the stern of the vessel would be exposed to the sea, while the bow was sheltered behind the breakwater?—Yes.

2381. And the same going out, a vessel leaving the harbour, the bow of the vessel would meet a heavy sea on her seaward bow and incline to turn her head in towards the land?—Yes.

2382. But still that could be guarded against by a careful navigator with her helm?—If they have sufficient power; but all steamers have not sufficient power.

2383. The vessels entering such a small harbour are obliged to come in with reduced speed, are they not?—They are obliged to come in with reduced speed.

2384. And they are obliged to slacken speed at the critical moment when they are exposed to this sea?—Yes, they are.

2385. In the event of a vessel getting to the north-east entrance and being obliged to go astern if she missed the entrance, would there be room to enter on the north side of the harbour, outside the line of surf; that is to say, presuming the entrance to be at the north-east and a vessel coming in with a north-east monsoon rollers, and missing it, and having to back astern, would there be room for her to anchor?—Yes, on the north side, there would be room; but by the time she had sufficient chain to bring her up she would be very close to the outer rollers, because the anchor does not hold in that ground.

2386. Of course, a badly-freighted vessel would yaw considerably more than the vessels that you have been accustomed to handle?—Precisely so.

2387. (*Chairman.*) A rather important witness that we have had gave it as his opinion that the rollers had very little force to affect the steering of the ship, do you agree with that?—It would have very great force indeed. Many times I have been holding my breath when I have been close to the beach to get my steamer round with the rollers abeam; it affects the steering of the ship very much.

2388. I am speaking of the possible force that might be exerted upon the bow or the stern of the ship coming out or going into the harbour?—It has a very considerable effect, it stops her from answering her helm.

2389. (*Sir John Coode.*) It is the rollers before they break that you refer to?—Yes, precisely so; we are compelled very often to go very close to the beach to discharge her cargo; if we did not go close to the beach we could not get boats. We must do that. Agents signal, come closer, so that we have had very great experience of turning a ship with the rollers close to the beach.

2390. (*Sir John Coode.*) Would your answer apply with equal force to rollers so far out as the line of entrance?—Yes, it would. I am speaking simply of the rollers of the sea, and before breaking.

2391. Do you think there is any difference between the effect of the roller immediately before it breaks and what it would be when it extends along the sea face of the work?—The shallower the water, the greater the force of the roller.

2392. Is there any marked difference in the height of the rollers as between the two monsoons?—Yes, I take it to be so.

2393. And the length as well?—Yes, the length as well.

2394. What difference would you say, in point of fact?—I could not say.

The witness withdrew.

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Captain JAMES SOMERVILLE MURRAY examined.

Capt. J. S. Murray.

2395. (*Chairman.*) What is the name of the ship that you command?—I am in command of the "Shannon," under the P. and O. Company.

2396. Are you well acquainted with Madras harbour?—Yes, I have known it for many years.

2397. Not only in the "Shannon" but in other ships?—Yes, since 1871; I have been on the coast frequently, every year until 1882.

2398. So that you saw it during its construction, up to its destruction, and since?—Yes.

2399. Were you in the habit of taking your own ship in and out or was that done by the harbour pilot?—While it was under construction I took my ship in and out myself, always. When they established a pilot, I, of course, was obliged to allow my ship to be taken in by the pilot, not willingly, I may say.

2400. Does it often happen to you to stop outside in the roads on account of the weather or any other cause since the harbour was made?—I have not been kept out by bad weather. It has not been my fortune to be there in such weather since the harbour was made.

2401. Have you ever had any hesitation about taking your ship in through the entrance in consequence of the strength of the current?—I have not found the current so strong that I could not do it, and I have not been kept out by it.

2402. What should you think is about the strongest current you have met with there?—It is difficult for one on board ship to say exactly with accuracy.

2403. Have you ever tried with the log?—No, I have not had time to make any experiments on it, and therefore I should not like to say, because my opinion would be more or less vague. I have not been there during any current which prevented me from getting in. I found it strong, but by making a little allowance I got in easily through the present entrance.

2404. Speaking generally, was there a decided advantage with regard to the working of the ship, getting in and out passengers, cargo, and so on, compared with what you have experienced when you have been lying in the roadsteads outside?—Most undoubtedly. Even before the harbour was made, as soon as the northern arm was carried out. I took advantage of it, and my ship was the first large ship that ever came in there. It came out and invaded my anchorage, and the advantage was very great indeed; there was no question about that.

2405. Have you often seen the water so bad inside owing to the sea running in through the entrance that the work of the ship has been materially interfered with?—No, that has not been my experience to any great extent.

2406. And you have visited it, I think, at all times of the year?—I ought to say now that since the harbour was made my experience of it has not been so great since 1882, I have not been there much.

2407. But that was after the harbour was made and destroyed?—Yes.

2408. When the harbour was at its best, did it afford valuable protection for ships carrying on their ordinary work?—Most valuable.

2409. Do you think that the entrance was in the best place?—No, I do not. I objected to the original plan of the harbour altogether, and therefore I am altogether against that entrance. I was one of those who were asked for a nautical opinion early in the matter, before it was made.

2410. Do you think that reducing the width of the eastern entrance from 550 feet to 450 feet would remove the objection to any appreciable extent?—No, I do not think it would be worth it. It is not very much too wide with the current which runs there now.

2411. Do you think that it would be an improvement to the harbour to close up that entrance and to make another entrance in the north-east corner, such as you see on that plan No. 3?—Yes, I hold that opinion, as making the best of the harbour as it is.

2412. Supposing your ship to be somewhere between 450 and 500 feet long, and a swell setting in the line of the beach as usual, and a north-east monsoon (I do not mean an exceptional one, when you would under any circumstances remain out and wait for a change, but a fresh north-east monsoon) blowing, should you feel any difficulty about running the ship in shore there, not very far from the line of breakers, and turning out into the north-east corner?—In fine weather there would be no difficulty whatever, but it would be a question about going in at all, if there was some cyclonic north-east sea running.

2413. Do you think you would hesitate to take your ship in through a north-east entrance in any weather in which you would take her in through the present east entrance?—With the reservation that I would probably find it easier to come in by the eastern entrance. It would be a question whether it was worth while coming in at all, if there was a very heavy sea on; it would be somewhat easier to come in at the east entrance; I do not see much difficulty in ordinary weather in coming in.

2414. And the state of the water in the harbour would be very much improved?—It would be very much smoother in ordinary weather. I have to modify my previous opinion which is on record here, and to say that there was a reservation that all cyclonic weather would entirely preclude entry into the harbour with a north-east sea and the approach of a cyclone. My reasons for not going in would be not alone to escape the risks of the harbour, but to avoid the hurricane altogether by going to sea.

2415. You mean through the north-east entrance?—Yes, through the north-east entrance, or indeed through any entrance.

2416. But not more through the north-east entrance than the present one; I mean when you are standing on the bridge with all that responsibility on you?—I have said that nothing would induce me to go into the Madras harbour when there is cyclonic weather. I will when a proper breakwater is made, but with the first breakwater that was broken down I would not under any circumstances in cyclonic weather enter the harbour as it was previously.

2417. You have probably thought over the question a good deal; is there any other way that you could suggest for improving the harbour?—It lies between leaving the entrance where it is, and making a north-east entrance. I cannot suggest anything to the south-east.

2418. Between those two, east or north-east, to which do you give the preference?—Clearly and distinctly to the north-east, provided that the sea-wall will remain. One might venture in at the north-east entrance and be caught in a cyclone if the breakwater is good.

2419. Then you think that the harbour could be made a harbour of refuge in case of a cyclone?—No, I certainly cannot go so far as that. It would influence one very much if one was sure that that wall would not go down.

2420. (*Sir John Coode.*) Assuming that a good and sufficient breakwater were erected, then you could; is that what you mean?—I then might be induced to go in on occasions when I would not think of going in now, because it is more or less a trap if you cannot get out.

2421. (*Chairman.*) When you speak of cyclonic weather, do you mean at particular times of the year or during the change of the monsoon, or do you speak of something that you can see by the barometer and the state of the sky and the sea and so on?—I mean in the presence of a cyclone passing to the northward or approaching from the eastward. I have remained there for three or four days sometimes, watching and waiting, lying outside with a single anchor down and ready to go.

2422. (*Admiral Sir George Nares.*) If you were inside so small a harbour with five or six large vessels and a cyclone coming on would you, with your experience, go to sea if you could get out?—Certainly, if I could see my way clear to get out without a collision. But that refers to what I said before, that it would be more through my being caught inside than through going inside willingly, if I was there on such an occasion.

2423. (*Chairman.*) Have you ever heard the suggestion to put a breakwater outside the present east entrance?—I have merely heard of it, and I should like it better a good deal. The north-east entrance as on plan No. 3 is unsatisfactory, but it appears to me to be making the best of the harbour as it is, although it is not at all what one would like.

2424. You think it would make the best of the harbour as it is?—It is a plan which appears to me to have considerable merit.

2425. (*Admiral Sir George Nares.*) It is the best way of patching up the harbour in fact?—It is the best way of patching up the harbour.

2426. (*Chairman.*) One of the great wants of the harbour, so far as we can learn, is a safe haven for harbour boats, dredgers, tugs, and so on, and it is believed that that entrance would give that, whereas they would never be safe with the harbour open to the eastward, do you agree with that idea?—I think those who have seen a cyclone running in there would be better able to judge than I of what amount of sea would enter the eastern entrance.

2427. Have you taken any notice of the advance of the sand, owing to the harbour?—I have, from the very beginning. As the northern arm was made I kept watching it separately, and it is my opinion that the whole thing would be overlapped in time, judging by the amount of sand accumulating to the southward; it is a question of time.

2428. Can you see the advance of the sand inside the harbour?—Yes, you can on the beach.

2429. Is the harbour silting up?—The beach has grown inside. I do not know whether that was the result of this sand which has accumulated there in the first instance before the southern arm was made, I rather think it was. The water off the pier appears to be the same, and I may say it is so practically, because I have observed it and I have sounded. I came as close to the pier as I do now when the north arm was only three-fourths of its present length, and I do not think there is any silt coming in through the entrance.

2430. (*Sir John Coode.*) We have had evidence from one of the other witnesses that the distribution of the sand along the beach has been mainly owing to the accumulation of sand on the north side of the pier in the earlier stages?—The water is just the same off the pier head.

2431. (*Chairman.*) Have you ever seen the beach inside the harbour so free from surf that you could land upon it in an ordinary ship's boat?—Yes, frequently.

2432. Has that ever been done within your knowledge?—I do not know that it has been done, but I could have done it if I had been required to do so.

2433. (*Admiral Sir George Nares.*) But there are more facilities for landing at the steps or on the pier than there are on the beach, are there not?—Yes.

2434. And people go to the pier in preference?—Very naturally, because they can step out dry.

2435. (*Chairman.*) The quay end of the pier is outside the line of surf, is it not?—It is outside the line of surf altogether.

2436. (*Sir John Coode.*) We may gather from you that the best thing to be done with Madras harbour (looking to the state that the work is now in, and the money that has been expended upon it), would be to close the eastern entrance and to make a new one to the north-east; is that the conclusion which you wish us to draw from your evidence?—I should like to be quite clear upon that point, and to know whether the old work has been repaired.

2437. The old work has been repaired according to the portion coloured red, with the addition of a rubble bank on the sea face, and continued the whole length; the superstructure is to be completed to the extent shown by the red tint on the plan on the table. Of course that is a question of money, but what we want to know is what is the best thing to be done in your judgment, irrespective of money for the moment; putting aside the question of cost and the possible removal of some portion of the work which you would like to see removed, what then would you recommend should be done with regard to the formation of a north east entrance; do you approve of this plan No. 3?—I find myself in a very difficult position, because I utterly and entirely disapproved of the plan from the first.

2438. You see we are face to face with certain facts and what we would like to have from you is, what in your opinion is the best thing to be done under existing circumstances, setting aside for the moment your disapproval of the original project. We have now before us a certain existing state of things, what would you say is the best thing to be done under the circumstances?—The north-east sea is a soul-stirring one, and sometimes it lasts two or three days when a cyclone is passing over towards Coconada, and that would be a very weak point with this north-east entrance. That is the only weak point that there is, with the exception that it is more difficult in getting in.

2439. (*Chairman.*) But do you think it more difficult to get out?—Certainly, it is more difficult so get out if you require to come out for safety.

2440. Do you mean in consequence of the position of the mouth or on account of the ships lying there?—On account of the two turns that you would have to make. You would have to turn within the harbour in order to point the vessel's head straight with the entrance.

2441. Then after having reached the outer end of the covering arm you would have to turn again in the beam rollers?—Yes, that is what I mean. The first would be the greater difficulty; that is to say, in turning within the harbour.

2442. Do you mean from want of space?—Yes, from want of space, and perhaps with a good many ships lying there.

2443. What do you think would be the greatest number of ships that Madras harbour would hold, still leaving you room to turn comfortably and with safety as you would wish; you would have no difficulty whatever if there were no other large ships than your own in the harbour, I presume?—No, there would be some leading buoy inside the entrance to turn upon. I do not remember how many vessels the harbour was arranged for. All the outer portion of the harbour would have to be kept open certainly, and the vessels would then come out into that open channel from their moorings.

2444. (*Sir John Coode.*) The extent of overlap which you see on this plan No. 3 before you is 500 feet, which is about the length of a vessel, should you think that that would be sufficient, or would you like to see that extension increased?—I should like to see it more northerly.

2445. You think it is likely that more than these 500 feet would be required?—Yes, certainly.

2446. Supposing that it rested with you to determine what length that overlap should be, how much would you recommend that it should be increased?—For the protection of the entrance and to keep out the north-east sea it ought to be perhaps double that length so as to overlap the northern arm of the harbour.

2447. That is for the purpose of rendering the water within the harbour quiet?—Yes, and the entrance tolerably quiet also.

2448. And the vessel should be free from any dangerous influence of the sea, when she was actually passing through the entrance?—Yes.

2449. Eight hundred feet has been suggested to us; would that be enough, do you think?—Yes; perhaps 800 or 1,000 feet.

2450. You think that not less than 800 feet would be desirable?—No, I think not.

2451. You say that the period over which your experience of Madras extended was from 1871 to 1882, were you there frequently during that time?—Very frequently, I might have gone in and out of the port of Madras six or eight times a year.

2452. Over the whole of that period?—Nearly all that time.

2453. Then your experience of Madras has been very considerable?—Very considerable.

2454. Are you aware that it has been proposed to raise those walls to 12 feet above sea-level instead of 6 feet as they were originally; that has been recommended, and so far as we know the Madras Board have adopted that recommendation; do you think that that would materially affect the quiet of the water within the harbour?—It would help considerably.

2455. Do you think that this 500 feet is too wide for a north-east entrance?—No, I think that 500 feet would be a very proper width for a north-east entrance to start with.

2456. Neither too wide nor too narrow?—No, its present width being 550 feet.

2457. (*Chairman.*) You say that you objected to the plan from the very beginning, would you tell us what was your objection to it?—My objections were these, that easy ingress and egress should be obtained for Madras, so that one might make good use of the fine weather up to the last moment and escape when you wished to do so. I thought that a detached breakwater parallel to the shore, with ends bent towards the shore, was the thing for Madras; and I saw that the littoral action would be a very serious matter.

2458. (*Sir John Coode.*) And you still think that that would have been the best mode for providing shelter at Madras?—I do, because the ultimate object of the harbour cannot be arrived at, which is getting the ship alongside the wharf and the railway alongside the ship; and that could scarcely be hoped for at Madras.

2459. Are you aware that the people at Madras urge this plan No. 3 on that very ground, that they would be able to construct jetties and piers off from the shore, and so be able to carry on their traffic there; do you think that their object will be accomplished if the eastern entrance is closed and a new one is made to the north-east; do you still think that the harbour will not be sufficiently quiet inside for vessels to be alongside the jetties?—I do not think it would in all weathers.

2460. Would the exceptions be many or few?—The exceptions would be frequent in October at the change of the monsoon.

2461. Would you say only in October or at the change of monsoon again in spring?—At the change in the spring, but more frequently at the end of the summer. So many cyclones pass across to the northward which would send a very disturbed sea in, and the north-east entrance would allow the sea to come in to some extent.

2462. The prevalent idea at Madras seems to be, as we gather it, that the construction of this north-east entrance will do away with all difficulties and that they will have a harbour within which they can carry on their traffic at the jetties easily the whole year round; that I understand you do not agree with?—No, I think it is scarcely possible at all seasons.

2463. Do you think that it would be insufficient at any other time than during the month of October and again during the break of the monsoon in February or March?—At any time in the north-east monsoon, and at any time in a cyclone crossing to the northward, I think that the north-east sea will search the harbour out.

2464. Even with any extent of overlap, I suppose, the overlap will not affect the run of the north-east sea into the harbour?—It will make it smaller, but I think it will prevent the ships lying alongside the jetties.

2465. (*Admiral Sir George Nares.*) In your opinion given to the master attendant on the 5th August 1883, regarding the north-east entrance, you say that there is no question about closing the eastern entrance; is that with reference to the quietude of the water inside the harbour or with reference to the facility of entering or egress from the harbour?—It is with regard to quieting the water inside.

2466. Then your evidence before the master attendant is purely regarding the commercial facilities inside the harbour; it is not in connexion with the navigation point of view with reference to entering or leaving?—It is entirely with regard to the commercial advantages.

2467. Then the great desideratum is the quietude of the water inside?—That would be the first, if there is a passable entrance and safety to ships.

2468. Could you give us any idea about where in the north-east monsoon the sea would begin to top before breaking at the north-east entrance, if opened. I ask the question in connexion with the force of the beam rollers against the bow or stern of a ship as turning into the harbour; would the vessel meet the ordinary rollers or would the rollers have topped at all in the seven fathoms at the entrance?—May I ask whether you suppose that a ship is entering in that weather?

2469. Yes, entering in the north-east monsoon, for we have information that practically all day and all night long, when the north-east monsoon has once commenced, there are continuous heavy rollers coming in nearly beam on to the shore, and I want to know how they are likely to affect a ship on entering or leaving, except in ordinary monsoon weather?—I do not think that it would probably have any effect in ordinary monsoon weather. We have worked our cargo outside the harbour there every day in ordinary monsoon weather, in masoolah boats alongside, and in lighters too.

2470. Before the harbour was constructed, in what water did you anchor?—I anchored in about 8 fathoms. From 7 to 8 fathoms.

2471. That would be in about a line with the proposed new entrance?—Yes, it would be that. I never went further out than 7 or 8 fathoms.

2472. And therefore the seas had not commenced to top then?—Not at all. I can speak most distinctly on that point from long experience. We could not do our work from morning till evening without coming close in, and I have never been sorry for coming close in, in 7 or 8 fathoms, and I have been in in 6 and 6½ fathoms.

2473. In leaving Madras and shaping your course to the southward, would you make an offing before turning southerly course at once during the monsoon?—I should take a straight course immediately after clearing the shipping.

2474. Then in point of fact, if a vessel can leave the north-eastern entrance with her bow pointed north north-east, she could continue that course without endangering her cargo with the beam sea?—North-north-east is about the trend of the land.

2475. You would have to make a north-north-east course to get out of the north-eastern entrance, because, as designed, the piers lie in a direction north-east, bearing one from the other, and to leave at all a vessel must be on a course to the north-north-east, or some course to the northward of that point and exposed to beam rollers in leaving; would that endanger your cargo or would you sooner point your vessel's head more to the eastward as soon as possible?—As soon as you round the breakwater end you would naturally let her go out to seaward.

2476. But you do not think that the beam rollers would affect the ship much?—No.

2477. Would not the force of the sea on the bow of a sailing ship as she is passing this tend to incline her bow towards the shore?—I do not think so, if the ship has sufficient immersion and sufficient power and is properly under command. If she is too light and has no steam power she may come to trouble anywhere, but a vessel that is properly under command and properly freighted would come round all right.

2478. Can you tell us anything about the character of the cargo steamers that work along that coast?—Yes.

2479. Do they proceed to sea badly stowed with the bow up in the air as we see them in England sometimes?

Capt. J. S. Murray. 24 June 1887.

—No, they are generally very fairly well stowed and fairly trimmed.

2480. Then we may not take it into consideration that vessels would have to take this entrance badly stowed?—Certainly not, generally.

2481. But they would all be under proper command?—They would all be very fairly well trimmed.

2482. In entering such a small harbour you have to ease speed, have you not, before entering; you could not run in there at full speed and with your ship thoroughly under command?—No, you would make the turn at a low rate of speed and increase the speed as it was necessary when the ship was pointed for the entrance.

2483. Would it be as easy for you to enter the harbour at a north-east entrance with a ship with reduced speed as with an eastern entrance?—No.

2484. Where would the difference lie?—There is a difference; it is not so easy.

2485. Supposing that the water in the harbour could be quieted in any other way, would you then prefer an eastern entrance or a north-eastern entrance?—An eastern entrance.

2486. Then, irrespective of expense, if the eastern entrance could be covered and smooth water obtained you would prefer that to a north-eastern entrance?—I should, certainly.

2487. Supposing that a covering breakwater were placed in advance of the eastern entrance, at what distance should it be to seaward to give clear room for manœuvring a vessel; the harbour itself being 3,000 feet from the shore to the end, what should be the least distance outside with a vessel 500 feet long that should be given?—We would have to keep in view that there is a considerable current running across the entrance.

2488. Could it be less than 2,000 feet, do you think?—No, not very well, I am thinking of the room in the harbour, and it cannot be less than 2,000 feet.

2489. Could you give us any idea of the number of points that a vessel would be yawing in entering that north-eastern entrance with the north-east monsoon; would you say that she would yaw a point on each side of her course?—No, we have such an enormous command of steering power that I do not think that would be necessary.

2490. I mean the yawing of a vessel with a heavy rolling sea abeam, and were you do not meet with the helm at all?—I should think that under circumstances which would be safe for entering it would not be more than a point, indeed, it would be less than a point.

2491. It would be half a point each side, would it not?—Yes, it would perhaps be half a point each side.

2492. You have not measured the current setting down with the monsoon, but would you say that it would run two knots an hour?—Yes.

2493. We have it in evidence that it is about two knots an hour?—It would run more than that, perhaps sometimes.

2494. And increase slightly with the tide?—Yes.

2495. Such a current striking against the north pier must form an eddy and cause a current to set outwards from the land along the pier if the north-eastern entrance is opened and there being an eddy where it would be setting across the entrance and against the covering arm of the east pier; will you consider that point and think whether that will affect ships entering with this rolling sea?—There must necessarily be an eddy there, but I do not think it would be very different from the eddy at Port Said, where you have a constant current setting to the eastward.

2496. If there were any protecting breakwater outside the eastern entrance would not that occupy the present anchorage of sailing ships; whereabouts do they anchor?—They anchor now north or south of the harbour, but seldom opposite the entrance.

2497. (*Chairman.*) Since the harbour has been constructed, have you ever landed cargo outside; I believe all the railway plant and other things of that sort are landed outside on the north side of the harbour; have you ever done so?—No, I have never done so.

2498. (*Admiral Sir George Nares.*) Whatever difficulty there may be about this north-eastern entrance you think that a well found ship could get in and out in all reasonable weather if the entrance were changed?—I do, in all ordinary weather, certainly.

2499. But still in a cyclone if a vessel is caught inside she could not get out, and you would not like to take a vessel out?—I should have no hesitation in getting out if I could get the ship pointed.

The witness withdrew.

Captain ARCHIBALD ADAMSON examined.

Capt. A. Adamson.

2500. (*Chairman.*) What ship do you now command?—The "Brindisi," one of the P. and O. Company's steamers.

2501. Have you frequented Madras harbour for any length of time?—Yes, for some time.

2502. Before the harbour was built?—Yes, before the harbour was built.

2503. And during its construction down to the present time?—Yes.

2504. When the harbour was completed did you find any great advantage from it?—In the matter of discharging cargo it is an advantage, although there is a considerable sea on inside even now, at times.

2505. When the harbour was completed, you frequently had a considerable sea?—Yes.

2506. So much so as to interfere with your work?—No, but enough to make the boats toss about very considerably, and packages are still dropped overboard on that account frequently.

2507. To anything like the same extent as they would be outside in the roadstead?—Very much the same.

2508. Does the rough water come through the entrance?—Yes, it comes through the entrance.

2509. Did it come through the entrance when the harbour was completed?—Yes.

2510. Do you think that that is the primary cause of the confused state of the sea inside the harbour?—Yes.

2511. Not so much the sea that breaks over the walls as the swell which comes through the entrance?—Ever since the walls have been broken down there is much more sea, but even before that entrance, which is a large entrance, the wind from the east would always send in a jobbly sea.

2512. Do you think that if the harbour were reconstructed on the old plan, but with the entrance 100 feet narrower, that would make any perceptible difference?—The entrance is quite wide enough for any ship of any size, and it might be certainly reduced, I think.

2513. There is also an alternative scheme of closing that entrance and opening one to the north-east, as you see on plan 3, with a covering arm which may be produced as far as necessary to keep the sea out of the entrance, with the wind in any direction; do you notice that?—Yes, I see that.

2514. Will you imagine yourself on the bridge of your ship with a north-east monsoon and the swell on your beam setting in a line with the beach, as I believe it usually does, with the surf breaking out at 4½ fathoms, which is about half way along the northern arm; should you like taking your ship into that entrance under those circumstances?—No, there is no room to manœuvre a ship to get her round inside the harbour. There is no room to work your ship coming into the north-eastern entrance.

2515. Then, from your point of view, you would prefer the entrance where it is?—I would prefer the entrance where it is.

2516. Supposing that were to be carried out, we may presume that the water would be smoother in the harbour; would you sacrifice that smoothness of the water for the sake of keeping the entrance where it is?—No, the entrance where it is now I should prefer to a north-eastern entrance.

2517. You would rather keep the water disturbed as it is now than move the entrance to the north-east?—Yes.

2518. That is so far as ships of the class of your ship are concerned. Another point of view is that supposing the entrance to be closed up and the entrance opened to the north-east with a protecting arm, it is confidently hoped that tugs and large cargo boats and perhaps even dredgers might be kept with safety in the harbour in

cyclonic weather; would that affect your opinion?—No.

2519. You think that the danger to ships entering and leaving the harbour is quite conclusive as regards that?—I think quite conclusive.

2520. (*Sir John Coode.*) What is the tonnage of the "Brindisi"?—3,542 tons, and her length is 368 feet.

2521. Is she the largest ship you have ever taken to Madras?—Yes.

2522. Does your experience of Madras extend over a lengthened period of years?—Since 1859.

2523. Continuously?—Not continuously; sometimes I have been away for five years. I was on the Australian line for five years.

2524. About how many times a year since you last returned have you been in and out of Madras?—The last two years I have been six voyages in and out, that is 12 times, say.

2525. If I understand aright, your answer to the question of the Chairman, the damage to goods in loading or unloading is no greater inside the harbour than outside?—No, it is not.

2526. We have been told that the sea is of a different character; is that so?—Yes, it is a shorter sea.

2527. I should have imagined that a chopping sea of that kind would be somewhat more dangerous?—For boats it is really more dangeeous.

2528. And more likely to knock the goods out of the slings?—Yes, it would be more likely to knock the goods out of the slings, certainly.

2529. If there is not an advantage in that respect, wherein lies the benefit of the harbour?—Personally, I do not see any benefit from the harbour at all.

2530. We have been told by more than one witness that what benefit there is rather lies in people bringing the ship nearer to the shore than they would be able to do without the harbour?—Yes, that is an advantage; but when you go in there you are lying in a dangerous position the whole time.

2531. Have you ever had occasion to leave the harbour under warning?—No, I never have, but I should say that if you had a warning to get out of that place you could not do it with a north-east entrance.

2532. Where would the danger lie; in what respect?—The danger would lie in not being able to get your ship pointed.

2533. From want of sufficient space?—Yes.

2534. But supposing that yours was the only ship in the harbour, you would have no difficulty then, would you?—Of course one would have more room, but there would be a difficulty there even so, in pointing the vessel properly to get out through the north-east entrance.

2535. With how many ships in the harbour do you think you could get out of that old entrance without difficulty?—With six ships in the harbour you could get out.

2536. But with the entrance at the north-east you would like to have the whole harbour to yourself, and you do not think that that would be too much?—It would not be too much.

2537. (*Admiral Sir George Nares.*) With the eastern entrance do vessels lie with their bows pointed to seaward?—Yes, to the east.

2538. Is that by a stern hawser or does the sea keep them pointed that way?—It is by a stern hawser.

2539. Then with this north-eastern entrance, if the buoys were placed differently, could they keep the bows of the vessel pointed more to the north-east than they do now?—Yes, but only in one part of the harbour, if the ship's head were pointed to the north if she was inside there might be a difficulty as you have a turn to take.

2540. Then there is not room in the small harbour to have a buoy at the entrance for the one special ship that is going out to turn at?—Yes, there is room for that.

2541. Supposing your bow is once pointed in, would you have any objection to the sea on your bow as you passed out under the protection of the protecting arm?—No, not in a full powered ship, certainly not.

2542. And in entering, would you have any objection to the sea on your quarter with your bow protected behind it?—Yes.

2543. You think that would be a dangerous position?—Yes, it would be a dangerous position.

Capt. A. Adamson. 24 June 1887.

2544. Vessels approaching the north-east entrance must necessarily ease their engines, must they not, before entering?—Yes.

2545. Then you think that vessels, if once pointed, could get out of the north-east entrance, but it would always be a dangerous course to them with a north-east monsoon?—Yes, I do.

2546. I suppose the great desideratum there is smooth water for cargo facilities?—Yes.

2547. And that is probably the reason why the north-east arm is designed, to give as quiet water as possible?—Yes.

2548. With the present harbour, as long as the eastern entrance remains, there can be no shelter for small craft in a cyclone, can there?—No.

2549. With the harbour in its present position we must take it for granted that they must go to some other part of the coast in the cyclonic season or they must go ashore on the beach?—They must certainly go ashore upon the beach.

2550. Have you ever thought about securing the eastern entrance with a detached breakwater at some distance to seaward, so as to produce smooth water inside the harbour in that way?—Yes, I have thought about it.

2551. If that could be done at about the same expense as it would cost to open the north-east entrance, which would you prefer?—I should prefer the detached breakwater, if it was taken far enough out to sea.

2552. What would be the minimum distance that it should be carried out to sea, considering that the harbour itself is 3,000 feet from the shore to the entrance, assuming a vessel to be about 500 feet in length?—You would want a little over just half the distance; I should say something more than 1,500 feet.

2553. Is the place which such a breakwater would occupy ever used now for vessels anchoring?—Yes, that is the place where the sailing ships all anchor now.

2554. Do not they generally in a north-east monsoon anchor to the southward of the harbour?—The lighthouse bears about eastward, and that is the best anchorage.

2555. That would be southward of the site that the breakwater would occupy?—Yes, a little to the south of that.

2556. But practically if such a breakwater were constructed the vessels that anchor there now could anchor elsewhere?—Yes, certainly.

2557. We have been told that there is a considerable strength of current from the northward in a north-east monsoon; might we take that at about two knots an hour?—Yes.

2558. And sometimes it is stronger, is it not, with an ebb tide?—Yes.

2559. This current striking against the north pier must cause an eddy just where the north-east entrance would be formed?—Yes.

2560. Would that increase the difficulties of a vessel entering or leaving?—Entering, certainly, or anything that would affect the steering of the ship when you have got small way upon her. When you are going out is a different matter. You can put on plenty of power and have your ship under better command.

2561. Leaving Madras for the southward and making a south course, if you altered your course immediately you were outside the harbour you would be exposed, would you not, to a beam sea?—Yes.

2562. Do you practically make an offing or do you make a course at once?—We make an offing to escape the beam sea.

2563. About what amount of yawing would a good fresh north-east monsoon sea cause in a well stowed vessel. We will suppose that you are approaching the north-east entrance in seven or eight fathoms of water in a line practically north-north-east exposed to a beam sea, would it amount to a point each side of her course?—It might do so. The strength of the wind catching her on the quarter might certainly make her yaw from a point to a point and a half.

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2564. In one of your earlier answers you said that the wind coming in from the eastward affected the cargo facilities; do you mean the sea coming in from the eastward, or the wind?—The sea.

2565. The wind very seldom comes direct from the eastward, does it?—That is so. Talking generally of the north-east monsoon, of course, it sends in the sea there.

The witness withdrew.

Adjourned to Tuesday next, at 11.30 o'clock.

At the Board of Trade, Whitehall,

Tuesday, 28th June 1887.

PRESENT:

VICE-ADMIRAL SIR NOWELL SALMON, V.C., K.C.B., IN THE CHAIR.

SIR JOHN COODE, K.C.M.G.

REAR-ADMIRAL SIR GEORGE NARES, K.C.B.

MR. F. C. THOMPSON [India Office], *Secretary.*

Capt. A. D. Fanshawe, R.N.

28 June 1887.

Captain ARTHUR DALRYMPLE FANSHAWE, R.N., examined.

2566. (*Chairman.*) You are captain of Her Majesty's ship "Jumna"?—Yes.

2567. You have recently been in the habit of visiting Madras harbour?—Yes.

2568. How many times have you been there?—Four times altogether. We ran between Rangoon and Madras taking troops. We came round the first time from Bombay to Madras, and we went there three times besides that, making four visits altogether.

2569. At what time of the year were you there?—In March and April. We left Rangoon last on May the 1st, and it was during the months of March and April this year that we were at Madras; in fact the 21st or 22nd of April was the day that we left Madras the last time.

2570. Did you go into the harbour on each occasion?—On every occasion we went in, and moored with two anchors down, and a wire hawser to a buoy. We came in and let go a port anchor, and turned, and then let go the starboard one, and then hauled astern to a buoy, having anchored generally outside the night before.

2571. Do you think that you gained any great advantage from going into the harbour with the harbour walls in their present state?—Yes, certainly for disembarking troops; in fact, the Quartermaster-General's Department would have objected very much indeed if we had suggested doing it outside on account of the distance.

2572. That is not the question; it is a question of whether there was any great advantage to be gained by going into the harbour?—No doubt in a rough sea the moving troops could be better carried out in whatever shelter the harbour walls now afford. As we were only there in fine weather, nearness to the beach for the masoolah boats was the only consideration as we were circumstanced.

2573. What was the state of the weather during your different visits; had you bad weather on either occasion?—The weather was favourable every time. The last time we went we took out the Hampshire and Somersetshire regiments, and they had had bad weather some time before. I do not think it was very much, but they had had bad weather, and we escaped that entirely.

2574. Have you ever seen bad weather there?—No, never. I had never been at Madras before this, except once for two or three days in 1876 in the "Undaunted" flagship. I was commander of the flagship at that time.

2575. Was your ship taken in by the pilot?—Yes, always by the pilot; it is obligatory.

2576. Did you find on either occasion any current affecting the ship going into the harbour?—No, I think not, at any rate no strong current. My staff-commander's evidence, I think, would be most valuable upon that point. I do not think that any officer in the service could give more thoroughly reliable information than he could give. We had no current sufficient to make the going in and out of the harbour difficult.

2577. During the months of March and April, which you say were the principal months, what sort of a sea or swell had you?—There was always more or less swell.

2578. Do you mean a swell setting in through the entrance to the harbour?—Yes, setting in. I think it was rather in that direction than any other.

2579. Did that affect the water in the harbour?—It made it necessary, I remember, the first time for us to, at any rate, have a short stay and to have a very long wire hawser put to the buoy, because we were afraid of bumping if we came too close in; and as she was an unusually heavy ship going in we had to take care not to bring her stern too far in for that very reason of the swell and the risk of her bumping.

2580. There was a perceptible swell affecting the ship?—Yes. As it happened it very slightly affected us, but with the swell that came when we were in there, if we had been too close in, we should have bumped.

2581. You were moored head on to the swell, I presume?—Yes, all the vessels are berthed in that way. There is a row of buoys along there, and five vessels can be berthed in one row, all with their bows straight out to the eastward.

2582. Do you think it would be safe to narrow the entrance by 100 feet, as has been suggested, it now being 550 feet?—I do not think that the entrance could be narrowed more than it is now. I think the entrance is in the wrong place, certainly; but I do not think you could narrow the present entrance any more than it is. There is very little room on each side of the ship going in; there is quite sufficient, but not any more than is requisite.

2583. If you had to run for it, you would not like to see it 150 feet narrower?—No; I should not have thought it was as much as 550 feet. Certainly a pretty big ship going in has sometimes very little space on each side of the ship, and, as I said before, I think it is in the wrong place.

2584. Where do you think it should be?—I think it should be made north and south with a breakwater; in fact, with two diagonal horns from the beach.

2585. Do you mean a breakwater outside the entrance?—As it is now, if the present entrance was built up and another entrance north and south parallel with the coast were made, that would be an improvement.

2586. You mean in the present harbour?—Yes, in the present harbour.

2587. Have you not made any observations as to the movement of the sand of Madras?—No, we were only in there for a very few hours, and we had no spare time at all.

2588. As a matter of fact, the advance of the sand on the south side of the harbour is so rapid and so regular that it quite precludes making an opening on the south side?—I presume you mean even if there was a separate diagonal pier coming out from the beach to prevent the sand silting along the beach, whether that would be better.

2589. In what direction?—If there was a diagonal pier coming down there, and if we had to do the whole thing, my idea would be to make the necessary breakwater parallel with the beach, and to make two diagonal piers on each side to keep the sand from silting, and to have a pretty wide entrance north and south.

2590. At present our business is to consider the reconstruction of the harbour, and whether any advantage would be gained by closing the east entrance and opening another. There can be very little doubt that if you could close that entrance you would get smooth water inside, and you would be able to keep there certain harbour craft that you cannot keep there now?—Yes, no doubt that would be so.

2591. Then there is this question from a seaman's point of view; whether that improved entrance would be a good one during the north-east monsoon for ingress under even ordinary circumstances, and for egress in the case of storm warning. Would you give us your opinion upon that, supposing that covering arm to be produced, we will say, for 1,000 feet, which is much longer than is represented on the chart, covering the entrance 500 feet, would you like to run your ship in with the sea constantly in that direction setting on to the coast with the breakers commencing at about half-way out of that northern arm and a squally north-east wind on your tail, would you like to take that entrance?—Yes, I think it would be a very great advantage. On the south side it silts up more than it does on the north, and, as a matter of fact, if you closed up this side entirely, it would be an undoubted advantage.

2592. You would not see any difficulty in taking the north-east entrance under the conditions that I have pointed out to you?—I do not think so, if the covering arm was produced for a considerable distance.

2593. The more you curve it in the closer you put the ship into the breakers?—Yes. I think there would be scarcely room to allow of curving it inwards without incommoding the passage of ships in and out.

2594. You would have to manœuvre then in fact on the very edge of the breakers?—Yes, five fathoms there extending half-way along the northern horn. I consider that if a covering arm were extended for some distance, there would be no difficulty in manœuvring the ship in.

2595. (*Sir John Coode.*) When you say some distance, could you give us an idea of what the length of the overlap should be; whether it should be a ship's length, or a ship's length and a half, or two ships' lengths?—I should say about three ships' lengths, say 1,500 feet.

2596. (*Admiral Sir George Nares.*) That, I presume, is to obtain perfectly quiet water before the vessel arrives at the entrance itself?—Yes.

2597. (*Sir John Coode.*) Do you think that you could venture in with anything like half speed, seeing that you have such a small space to bring up in?—Yes, I think so. I do not see any difficulty. As it is now with a ship coming inside that eastern entrance of the harbour, we have to turn right round with a great big steamer on each side of us; but there is not the slightest difficulty because there is no current inside.

2598. (*Admiral Sir George Nares.*) And you think that a north-eastern entrance, if made, must have that covering arm considerably lengthened?—Yes, I do think so.

2599. But without the covering arm there would be a difficulty in vessels entering or leaving with the north-east monsoon?—I think there would.

2600. Coming into such a small harbour you have to ease the speed of the ship considerably, have you not, before arriving at the entrance?—Yes, certainly.

2601. And then the sea has more power over the vessel?—Yes. We came in at half speed until we got very nearly up, and then we slowed just before we came in. We required a little way on her to get partly round after letting go the port anchor.

2602. (*Sir John Coode.*) Then the sea was right astern; whereas in the case of this north-eastern entrance it would be on the beam?—Yes.

2603. (*Admiral Sir George Nares.*) Would the sea have more power over your vessel abeam, or astern, or right ahead?—I think astern it would have more power; but I do not think I should mind a moderate sea on the beam very much, and it would be generally smooth inside the covering arm.

2604. (*Chairman.*) So long as you have a good steerage way?—Yes; if we have got way on, I do not see any difficulty.

2605. Can you give us any idea of about the amount of yawing that you experienced in the "Jumna" with the sea astern and with the sea abeam going half-speed?—Very slight indeed; but I have not experienced heavy seas in the "Jumna."

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2606. Would you yaw as much as a point each side of your course?—I do not think so. I think the ship is too big altogether for that, she would not feel anything unless it is a very heavy swell or a following sea which she would no doubt feel, but certainly not one that we experienced at Madras.

2607. Nothing that would prevent you from entering the harbour at all?—No, I think if the weather was suitable for taking a heavy ship under any circumstances into that very confined small space she could be taken in at the north-east entrance quite as easily as at the present one; but in any case, at any time, she ought not to be taken in if it is at all threatening weather.

2608. Having had no experience of cyclone weather there, are you able to appreciate the difficulty that some masters of ships see in getting out in a hurry in bad weather through a north-east entrance?—I can understand that getting out would be rather difficult; getting out as it is now is a very simple matter because you are pointing straight out.

2609. (*Admiral Sir George Nares.*) Have you never experienced any difficulty with the present entrance in going in or out?—Not the slightest.

2610. (*Chairman.*) Did you take notice of the surf on the beach inside the harbour?—Yes.

2611. Do you think at any time during your former visits you could have landed on the beach in the ship's boats?—We could have done so every time with some discomfort from getting wet, no doubt. I particularly noticed it the last time we went there. We took two British regiments, and I watched the operation of landing those two regiments on the beach, and the very skilful way that they worked those Masoolah boats. A string of them kept on straight to the beach with our baggage, and they did it very quickly and well.

2612. Do you think that the ship's boats could have landed them at any time that you were there?—Every time; but they would have got the water in and wetted everybody in the boat probably, but at the pier we landed perfectly easily.

2613. Was there much smell in the harbour while you were there?—No, I did not notice anything at all, no stagnant water about, or anything of that sort. It seemed to me that if this north-eastern entrance with an overlapping arm were carried out some distance, it might make sheltered anchorage water outside in the south-west monsoon time for small craft.

2614. Were there any ships anchored on the north side of the harbour, while you were there?—Yes, they were not quite so far in, they were in the north-east corner.

2615. Did you take many horses across?—Not many, but we took some every time.

2616. Where were they landed?—They were landed on the beach in Masoolah boats.

2617. (*Sir John Coode.*) On each occasion, when you were there, it was during the north-east monsoon, was it not?—Yes.

2618. What was the greatest length of time that you remained on any one occasion in the harbour; was it many days?—Never more than 36 hours at the outside.

2619. In what respect do you consider that great advantage was derived from the harbour when you were there. I am not quite clear whether you meant that you got your vessel nearer up to the shore, or whether it was that you actually derived shelter from the work?—As the weather was when we were there, I do not think we derived any benefit from the harbour. We could have come in and moored close to the shore if there had been no harbour there at all.

2620. Were all the troops landed on the beach, or at the jetty?—All on the beach.

2621. (*Admiral Sir George Nares.*) Your wish for a north-east entrance appears to be that you want to have perfectly quiet water inside the harbour?—Yes.

2622. Supposing that the harbour were perfectly quiet, would you sooner, from a navigation point of view, have the north-eastern entrance or an easterly

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entrance?—I would rather have a north-eastern entrance, I think.

2623. Then you would prefer, for every reason, a north-eastern entrance over an easterly entrance?—Yes, certainly, the only drawback being, that I think it would be more difficult to get out; that is to say, if you were caught in a cyclone, or anything of that sort, it would be difficult to get out of the harbour.

2624. Then for that reason you do not like a north-eastern entrance?—That is the only reason.

2625. And for getting out on the approach of a cyclone you would sooner have an eastern entrance?—Yes, certainly.

2626. Supposing for the same outlay of money the present eastern entrance could be protected by an outer breakwater about 2,000 feet outside, which would give a considerable amount of protection from the easterly seas coming in, would you prefer that, or would you prefer the lengthened breakwater and a north-eastern entrance?—I should prefer that if it could be found to be effectual, but I doubt if it would.

2627. Without going into the engineering question you would prefer it from a navigation point of view?—Yes; if it really gave smooth water inside, but I doubt if it would, and although an entrance on the north-east side might be less handy for ships to get out quietly, still, all things considered, I believe an entrance on the north-east side with a long covering arm to be the best plan.

2628. Have you noticed a strong current outside with a north-easterly monsoon on entering or leaving the harbour?—Always in making the port we were liable to be set either north or south every time, and always got the latitude frequently by pole star up to the last moment of sighting the light.

2629. When entering the harbour, did you actually feel the current affecting the ship?—I think not.

2630. We are told that it frequently runs at the rate of two knots an hour, and sometimes more, in a strong monsoon; is that consistent with what you observed?—It did not affect us actually in coming in and out of the harbour, at least it did not appear to me to inconvenience us in the very short distance the ship traversed to enter the harbour.

2631. Supposing that two knot current setting from the northward on to the north pier, and eddying round across to the north-east corner, have you ever thought whether that would affect your ship entering according to plan No. 3, because we are told that the current does set out after striking the pier?—A current would be awkward, certainly, to a big ship under those circumstances, but I doubt its being sufficiently strong to be dangerous if looked out for, at least at the time of year we were there.

2632. But you yourself were not aware of any current?—No, not at all.

2633. If an isolated breakwater were placed to cover the eastern entrance, what would be the minimum distance you would say that there ought to be left between it and the present harbour, the harbour being 3,000 feet in length?—As far out as is possible so as to be effectual, so as to actually stop the swell, and the farther out the better, to give room for ships passing in and out.

2634. You would not have it less than 2,000 feet?—No, I would not have it less than that.

2635. Four times the length of the ship?—I should have it of considerable length, but, of course, that would be an engineering question altogether. I would have a good long breakwater as far out as I could go so as to be effectual. If I had to make the harbour again I would not make it at all where it is now. I think that a breakwater outside from an engineering point of view, if there was a good prospect of its being successful, would be a very good thing to have, but I do not think it would be effectual.

2636. Are you aware that the rubble face for the new works has been actually completed with a view of rebuilding the harbour on the old plan?—No, I am not aware of that.

2637. And all that has now to be done is to put the blocks upon it?—I am aware that it is knocked down, and that they are working at it, I suppose, restoring it to its original condition.

2638. If a north-eastern entrance is opened, how much of the present rubble base, do you think, ought to be removed, and to what depth, would you remove it?—So as to allow a width of 700 feet, at least, that would be 150 feet more than the present eastern entrance.

The witness withdrew.

Staff-Commander WALTER S. CHAMBRE, R.N., examined.

Staff-Com. W.S. Chambre, R.N.

2639. You are Staff-Commander, are you not, of the "Jumna?"—Yes.

2640. How long have you been in that position?—I have been three years in the "Jumna."

2641. During that period how many times have you visited the Madras harbour?—Four times.

2642. During what months?—My visits were in March and April.

2643. Had you no previous acquaintance with Madras harbour?—No.

2644. Did you take your ship in yourself, or did the pilot take her in?—The pilot took us in.

2645. Did you notice any current affecting the navigation of the ship in that harbour?—Yes.

2646. To any extent?—Only so that you had to keep close to the southern arm going in.

2647. The current runs from the southward?—Yes, from the southward.

2648. (*Admiral Sir George Nares.*) With the northern monsoon?—There was hardly any wind when I was there; there had been a long shore wind.

2649. (*Sir John Coode.*) This was just about the time when the break of the monsoon was expected, was it not?—Yes.

2650. (*Chairman.*) Was there any swell on at the time?—No, there was no swell.

2651. I mean, supposing you had been lying at anchor in the roads outside, was there enough swell to make the ship roll?—Yes.

2652. Was that swell setting into the harbour?—Yes, setting straight on.

2653. Did that swell affect the water in the harbour?—Yes.

2654. If you had been moored north and south, would it have made the ship roll in the harbour?—Yes, at that time it would.

2655. You are aware, are you not, that the present entrance is 550 feet wide?—Yes.

2656. Should you, from a navigating point of view, object to its being narrowed by 100 feet?—Certainly.

2657. Do you think that 450 feet, which is a good deal more than the length of your ship, would be too little?—I think it would be too little for safe navigation.

2658. In fact it would not leave you enough room to allow for the set of the current?—No, it would not.

2659. Will you look at plan No. 3 before you, the red part of it is a proposal to close up the present entrance and to open an entrance in the north-east corner, extending the wall 500 feet to cover the entrance; should you think that an entrance there would be an improvement upon the present entrance?—Yes.

2660. For what reason?—Because of the swell always setting straight on to the shore.

2661. You think that you would get smoother water in the harbour?—Yes, I think so.

2662. Should you think that it would be a worse entrance to take a big ship in, say, in the north-east monsoon, with the wind behind you and the sea on your broadside?—Not with that length, I should not. If you give sufficient length to the covering arm it would be much easier, I think.

2663. You have never seen any cyclonic weather at Madras, have you?—No.

2664. So that you could hardly give an opinion as to getting out of an entrance like that on the threat of a cyclone?—No, only what I could imagine.

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2665. Should you think that there would also be an advantage in having an entrance to the north-east, over the east entrance then?—Yes.

2666. Did you make any observations on the currents and the sand while you were there?—No, our time was too limited; we only arrived at night and sailed at daylight the next morning always.

2667. To what extent would you carry out that protecting arm?—I should take it double the longest ship's length.

2668. Would you say about 1,000 feet?—Yes, quite that.

2669. And you would have no objection to take your ship in there in any weather in which you would take her in at the eastern entrance?—No.

2670. (*Admiral Sir George Nares.*) Your principal reason for changing the entrance from the east to the north-east is to obtain quietness in the harbour, is it not?—And to avoid the current going in, the current setting in either north or south.

2671. Supposing with a north-east entrance there were a northerly current running, striking against the north pier and setting out towards the protecting arm, would you prefer entering a north-east entrance under such circumstances to using an eastern entrance with the current setting directly across it?—I think that a north-east entrance would be a safer entrance.

2672. Even with an eddy and current there?—Yes.

2673. Then you object altogether to the eastern entrance on account of the cross current?—Yes.

2674. At what rate does the current set; we have been told that it is at the rate of two knots an hour?—Two knots was the greatest that we have had in our trips.

2675. Then you do not think that there would be any difficulty in going out in bad weather for a vessel taking the north-east entrance in seven fathoms of water and meeting the sea on her bow as she passes out clear of the covering breakwater?—I see no difficulty.

2676. There would be room to manœuvre there?—Yes.

2677. In coming in you have to ease the speed of the ship, have you not, before entering that small harbour?—Yes.

2678. A vessel is therefore not so much under command; but you still think that the north-eastern entrance would be safe enough for navigation purposes?—Yes. Of course I am answering for my own ship. Some ships work so much more easily than others.

2679. Can you put yourself at all in the position of a cargo vessel not well freighted; do you think that they would have a difficulty in entering under all circumstances if there was a north-eastern entrance?—I should think not.

2680. Supposing that for the same sum of money that eastern entrance could be covered by a detached breakwater, say about 2,000 feet in advance, would you prefer then to leave the eastern entrance open?—No.

2681. You would still prefer the north-eastern entrance?—Yes.

2682. Because you would still have the current setting across you as you entered?—Yes.

2683. But you have never experienced any difficulty in going in and out now?—No.

2684. You only contemplate it when there is a strong current?—Yes.

2685. (*Chairman.*) Have you ever discussed this question before?—We discussed it at Madras.

2686. (*Sir John Coode.*) With whom?—With the local people.

2686a. With Captain Taylor and the pilot?—No, only with the pilot, the man who took us in.

2687. Was that Horne, the chief pilot?—Yes.

2688. What is the largest amount of overlap which you think you would like to see of the eastern arm?—Certainly not less than two ships' lengths.

2689. Say 800 or 900 feet?—At least 800 feet.

The witness withdrew.

Mr. WILLIAM HENRY HORNE further examined.

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2690. (*Chairman.*) Since you were here before we have had evidence from the captains of steamers which rather points to the chief difficulty in their eyes being not the entry to the harbour, but getting out of the harbour in case of bad weather coming on suddenly, that is to say, a harbour with a north-east entrance, according to plan No. 3?—Of course, bad weather means that the wind is north-west, and it is in going into the harbour in bad weather we have to contend with the enemy.

2691. Supposing that plan No. 3 is carried out, how would you propose to moor the vessels, say that you have got in, and that you want your ship to have smooth water in the harbour, and you have got so much additional space, how would you propose to moor the vessels?—North and south. I have told Captain Marshall, the conservator of the harbour, that we must leave one berth vacant in the outside tier to pass through.

2692. Will you put yourself into the position, we will say, of an in-shore ship on the north side of the harbour. Is the position which I have drawn on the plan about the position that your inside ship would be (*handing a plan to the witness*)?—Yes.

2693. Do you think that you could take that ship so moored out at the commencement of a typhoon at the north-east entrance?—No, but if we got 12 hours' notice I could do so.

2694. But in the weather in which you ordinarily have to clear the harbour, you see no difficulty in getting her out of that proposed north-east entrance?—No, certainly not.

2695. Of course, I can quite realize that you would be able to help yourself with warps, but I can also quite realize that the presence of buoys in the harbour would be a danger of itself to the propellers?—Yes, it would; warps are no use to me. I read in Captain Taylor's evidence where he said distinctly that bollards or piers are what is to be used. But you cannot have bollards or piers within 20 feet of the surface. If you insert a bollard you must insert a bollard down to the bottom with the middle part of stone, the middle part meaning the nearest stone to the harbour, that would be four feet from the harbour itself; four feet is nothing to fall back upon to hold a ship by. I am only speaking of the point of holding the ship by, it is no use whatever. It is far better to have a ring in the lower part down below, and insert that ring inside and a clamp, like they have in Marseilles harbour.

2696. In a few words, you do admit the difficulty of clearing your harbour when there is a warning of a typhoon?—Yes, certainly.

2697. And more than in entering, because you would not enter the harbour under the same circumstances?—No, of course not.

2698. There is another point upon which I want to ask you, as you may have made some observations upon the subject. What becomes of the sand from the north-east corner?—That is very doubtful; it passes out to the south-east.

2699. Have you any doubt that it does pass out to the south-east?—I am certain of it. We see the discoloured water; it must pass out of the south-east.

2700. (*Admiral Sir George Nares.*) Sand coming from where?—From the north-west to the south-east.

2701. (*Chairman.*) On this part of the coast (*pointing to the plan*) the sand has all been taken away, and there is what is called erosion going on, is there not?—Yes.

2702. What has become of that sand, in which way has it gone?—I believe it has passed away to the south-east with a certain amount of lodgment on the south side.

2703. Does it strike you that this projecting arm will arrest that sand, and have a tendency to fill up the proposed north-east entrance?—I believe that it will stop at the groyne there, or it will come into the harbour through the proposed north-east entrance.

2704. Have you yourself noticed the sand being actually carried away from that north-east corner from the north side?—I have, but I could not give any

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official report about it. It has done so but it varies very much. I have a friend there who lives on the spot, and last November twelve months, and on account of a financial matter, he took the house he lives in from the harbour trustee. They gave him a house free to live in, and we blockaded his house to the eastward by sundry matters in the way of loose timber that we had attached to our pier or the go-downs. That caused a break and the sea did not strike immediately upon the house and the house still remains, so that that shows that with a little protection the sand does not float away from that part of the harbour on the north side of the arm, but I am of opinion that it must eventually go away, if the current is very strong on that side.

2705. (*Sir John Coode.*) Is it the current, or is it the sea stroke that takes the sand away, or both?—The sea comes in there.

2706. Then it is the action of the sea rather than of the current?—Yes, it grags away, it cuts the foreshore away entirely.

2707. The foreshore for a distance of a mile or a mile and a half to the north is protected by rubble stone, is that the case with your friend's house?—No, there is some of the Sailors Home entirely gone now.

2708. Was it ever protected by rubble stone?—Yes: but that is all gone.

2709. Has it been renewed from time to time as the matter washed down?—No. Since 1886 they have put up a foreshore in the way of a laterite. We have lost 125 feet fully of that foreshore.

2710. For any great distance north of the pier?—Yes, fully half a mile.

2711. Do you think that for fully half a mile you have lost a breadth of about 125 feet?—Yes, fully that; because at the Sailors' Home the sea broke the surface of the wall down, and went into the rooms downstairs in the cyclone.

2712. You have told us that there is a current at the back of the north pier running eastward. Have you measured it?—Not running eastward; it takes a circular form.

2713. I understood you to say the other day that the current at the back of the north pier ran to the eastward?—It strikes to the northward, and causes a collision there.

2714. What becomes of it when it arrives at the eastern end of the north pier?—The outside part of the harbour is all scattered; some part of it falls in, and the current loses force.

2715. How do you know that; is the water discoloured?—Yes, on account of the motion upon the superstructure of the breakwater.

2716. Do you see this discoloured water passing into the harbour?—Some portion of it.

2717. But the bulk of it runs away to the south-east?—Yes.

2718. (*Admiral Sir George Nares.*) And that water is discoloured?—Yes.

2719. (*Sir John Coode.*) Could you give us any idea of the rate of this current at the back of the north pier; have you ever measured it?—No.

2720. But knowing what you do of the measured rate and velocity of the current running past the eastern entrance, should you say that that which runs at the back of the north pier is stronger or less strong?—It is less.

2721. Much less?—About one half of the strength.

2722. Do you think that the current at the back of the north pier is about a knot an hour?—Yes, it is a knot there, and in other parts it is two knots.

2723. Captain Taylor told us that vessels lie here for a considerable time without any anchor at all; do you agree with that?—I read his evidence, but Captain Taylor does not always come afloat.

2724. Do you think that he has not the means of judging of the current as you have. I do not think the evidence points to that?—My evidence is simply an every day's occurrence.

2725. Do you ever use a tug within the harbour?—No.

2726. There is no tug appropriated for harbour purposes, is there?—Not at present.

2727. Is it intended to have one?—It will be requisite by-and-bye. If a north-east entrance is made we must have a tug inside, we must have steam power, otherwise we may be dropping our anchors upon the mooring buoys.

2728. Hitherto with an eastern entrance, no tug has ever been used?—No, it has not been required. As it is now, I steam straight to the moorings; but if you close up the eastern entrance I must have a tug inside, especially in the north-east monsoons.

2729. Does this current at the back of the north pier exist during the whole north-east monsoon?—It does. It varies of course, sometimes it is two and a half knots, sometimes two, sometimes one; and sometimes there is what you call a reaction, it does not set in at all, it is then still water. You may stop your ship there and drop your anchor, and ride with the chain perpendicular; perhaps two or three or four days.

2730. As a rule, during the north-east monsoon, does this current along the back of the north pier prevail, or does it not?—As a rule it does prevail from the north to the south.

2731. As a rule, how many days a week would you say?—I should say there would be about two days slack water in the course of three weeks, it depends upon the full and the change. The full and the change have an immense action upon the water at Madras.

2732. (*Chairman.*) Have you ever, since the harbour works have been there, seen any sand deposited on the north side of the harbour?—None whatever close to the harbour.

2733. (*Admiral Sir George Nares.*) Does not the beach grow slightly on the north side of the harbour in the north-east monsoon?—It has done so. I cannot get over that difficulty. I had a conversation with Mr. Hutchins, our deputy traffic manager. He has a house down there, and I have been down there, and advised him to leave his house; but it is very strange that after a cyclone is over, the beach seems to make up for some 12 to 15 feet; but how to account for it I cannot say. There must be a reaction because of the under-current.

2734. But in an ordinary monsoon current does not the sand collect up on the north side of each of the groynes slightly?—No, not in an ordinary cyclone, it is the reaction afterwards.

2735. I am talking about monsoon weather; does not the sand drift slightly south with the north-east monsoon on the north side of the harbour?—Yes, it is sheltered on the north side.

2736. But the current, you say, with a north-east monsoon strikes against the north pier?—Yes.

2737. And that current is discoloured?—It gets out the sand from the beach.

2738. If it is discoloured is it not discoloured with sand?—No; it is quite plain there, and true on that side; it does not get discoloured. The sand gets out, but you cannot see the water discoloured.

2739. The water near the shore is not discoloured?—No. It is very deep on the north side of the harbour; it is shallow on the south side of the harbour.

2740. But the discoloured water is more brown water as distinct from blue water?—On the south side it is discoloured, but on the north side the slope of the beach is very steep.

2741. I want to ask you about the current on the north side of the harbour, with the north-east monsoon, you say it is coming down along the coast?—Yes.

2742. And strikes against the north pier?—Yes.

2743. And that that water is discoloured?—Yes, it is discoloured close in shore.

2744. What is it discoloured with?—With sand and laterite.

2745. When that water is passing south and discoloured, do not the groynes along the beach fill up in the north side slightly?—Yes; but we have no groynes on the north side. I mean outside the north arm or wall.

2746. The chart shows that there are groynes?—There are no groynes there.

2747. Then the groynes in the chart do not exist?—No; that is all washed away; it is all sunk down with the motion of the sand, and the stones have gone downwards; it is all passed downwards on account of the quicksand. On the north side we have got true water, deep water, whereas in the south side of the south arm we have very shallow water.

2748. (*Chairman.*) Have you ever seen the foundation on the north side; is it nothing but sand?—It is all sandy soil. All the foundations are entirely sand.

2749. Then the only stone on the north side is what you put there?—That is so.

2750. (*Sir John Coode.*) And some considerable portion of that has disappeared?—Yes, that has entirely gone; the weight of the stone has gone down under the sand.

2751. It has been undermined by the scour?—Yes.

2752. (*Admiral Sir George Nares.*) Is there as much discoloration with the south monsoon as with the north, or which is most?—No, not so much with the south as with the north. The north has a very peculiar eddy. I could not give you the true version of the north-east monsoon, it varies so very much indeed. We have some days with no current, and then we have a two knots current.

2753. Still whenever you have a current, that current is a dirty current carrying sand?—Yes, it is dirty.

2754. With both monsoons?—Particularly with north-east monsoons, but not so much with the south-west, because in the south-west monsoons, and the sea from the south-east, and a lateral current running to the northward, there is not the same force; there is not the amount of sea; there is not that topping or lepping of the wave, it does not stir the bottom so much. And consequently a diver can see down below and can see where he is going to, and can hook on to anything; but in the north-east monsoon he cannot see anything at all, the motion is so great.

2755. And the water so dirty?—Yes.

2756. And yet the deposit of sand is principally during the south-west monsoon, is it not?—I could not explain it properly, but I think it is; I should almost say yes, that the deposit for nine months in the year is on the south side of the groyne.

2757. (*Admiral Sir George Nares.*) In fact the deposit with the calm monsoon being carried away by the rough monsoon?—No, there is no rough monsoon at all. I do not see the rough motion with the south monsoon, because nine months in the year we have a very pleasant time, the only thing that disturbs us is the north-west squalls; but that does not interfere at all, it is a brown sand.

2758. What I mean is that the sand is deposited in the fine weather monsoon from the southward, but is carried away to the southward during the rough north-east monsoon?—No, I think not. During nine months we have a certain amount of deposit; but on the south side of the harbour for nine months the sand accumulates, that is both windblown and also brought by the force of the current laterally with the shore south and north. But with a north-east monsoon there is a disturbance on the north side of the harbour in the groyne, where I have an idea that it lodges a certain amount, I might almost say one-third of the deposit into the same place as the south-western monsoon brings it. One-third of its action must fall in dead water and the other two-thirds must go out to the eastward and be carried away by the current.

2759. (*Admiral Sir George Nares.*) But there is no doubt whatever about the discoloured water?—No, not any; it changes twice or three times a week.

2760. There is no doubt that in the southerly monsoon it is clear water along the north side of the harbour?—Yes, it is blue water.

2761. But there is a slight discolouration on the south-east side of the harbour in a south monsoon?—We get it for months and on the south side.

2762. Where do the lighters load the rubble for the base?—They load inside the walls. In the south-west monsoon they load inside the south arm.

The witness withdrew.

Mr. William Parkes, C.E., further examined.

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2763. (*Chairman.*) Since we saw you there has been a new plan placed before the Committee, plan No. 3, by the Harbour Trust, which they have adopted as offering the most advantages. You will see that that plan does not remove any of the new work except the rubble, but that there is a certain length of rubble to remove, and that the arm would be projected in a straight line across the present easterly entrance?—Yes, I observe that.

2764. (*Chairman.*) From the arm or from the beach?—From the arm, not from the beach.

2765. (*Admiral Sir George Nares.*) Then the stuff is brought down by railway on to the present breakwater?—Yes, in ordinary iron waggons on the railway, holding 6, 8, and 10 tons.

2766. And put into lighters, and the lighter takes it out to where it is used?—Takes it out to the different places where it is deposited by instructions from Mr. Thorowgood.

2767. None of the rubble base is tipped over at the end of the breakwater, is it?—No; if it was it would be all gone, there would be no base at all, it would all level off. The current around the end of the work is so strong that there is a sort of whirlpool there; and if you flung a bucket full of soft stuff for the base and if you flung a bucket full of soft stuff from the bucket to the down and let it fall six feet from the bucket to the surface level it would all pass away from the level base down below.

2768. If you threw down 200 tons from a bucket it would have the same effect as throwing 200 tons from a boat?—Yes; of course you could not put it in; it would fall immediately down below.

2769. (*Sir John Coode.*) You spoke of a certain amount of lodgment on the north side of the south pier, did you not?—No, I have not spoken of it. Captain Taylor spoke of it.

2770. You said there was a certain amount of lodgment there?—There is something out there, but I can give no authentic account of it.

2771. What do you mean by shoaling; do you mean a reduction of the depth, or what?—Rather a discoloration of the water.

2772. There may be a discolouration of the water, but it does not necessarily follow that there is a lodgment, have you any evidence to put before us to prove that there is a lodgment there?—There is discolouration certainly.

2773. Your expression was "a certain amount of lodgment"?—I have never sounded it.

2774. When you said lodgment you meant discoloration?—Yes, because we have vessels out there in nine fathoms, and I never ask a captain what the soundings are from day to day from his diary.

2775. (*Admiral Sir George Nares.*) With the proposed north-east entrance you are to have, for a distance of 2,800 feet, new work, are you not?—Yes.

2776. If you could put down 2,800 feet of breakwater to protect the east entrance and keep the sea out of the harbour, which would you prefer, in a navigation point of view, a north-east entrance, or putting down an isolated breakwater east of the east entrance?—I should prefer a north-east entrance. Every shipowner must understand that they would be subject to, perhaps, one or two days' detention outside in case we had a great sea on, and we could not bring them in.

2777. (*Chairman.*) Also, I suppose, that once in they are more in a trap than they are now?—No; with a north-eastern entrance they would be far safer. They would not require to go out at all. If they had good moorings, and the eastern sea was blocked outside, they could stop there for ever.

2778. (*Sir John Coode.*) No matter how violent the cyclone may be?—No matter how violent it may be.

2779–82. (*Admiral Sir George Nares.*) But every captain without exception has said that even with a north-east entrance he would not stop in the harbour?—They have not been inside and they are funky. Of course the responsibility lies with the captain himself afterwards. When we hoist our signals to get up steam power and to go out, the captains get shaky upon the point; but when once they see that we have smooth water inside and good moorings, they will possibly think differently.

2783. (*Chairman.*) Since we saw you there has been a new plan placed before the Committee, plan No. 3, by the Harbour Trust, which they have adopted as offering the most advantages. You will see that that plan does not remove any of the new work except the rubble, but that there is a certain length of rubble to remove, and that the arm would be projected in a straight line across the present easterly entrance?—Yes, I observe that.

2784. With regard to that again we have had a great deal of evidence in favour of it, and some little evidence against it, and we should be glad to have your idea as to the probable cost?—I see that Mr. Thorowgood has made an estimate of it and he puts it down at about 20 lacs.

2785. The estimate which we have had before us is 14 lacs?—My estimate I think was rather less than

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that because it was based on rather different data. I think I explained that in the paper that the original estimate which I made for Sir John Hawkshaw's Committee I did not make any allowance for the cost of the two pier heads. Each of these would cost about a lac and a half, in addition to the ordinary design of the pier. If you had only one pier head, as it were, you would save that lac and a half, because you would make only one pier head instead of two pier heads.

2786. Would not you require a pier head at the end of the north arm?—That would be so completely under shelter that you would not want the extensive work which is required at the other two pier heads; and that reduced the original estimate by about a lac and a half. I think that, in working it out independently (it is put upon the little plan which I gave to the Secretary), it was at 11¼ lacs, that is what I worked it out to. But that was for an overlap of only 300 feet; this is 400 feet from the line of the pier, and that of course would be in addition.

2787. There can be little doubt that it would be necessary to carry that out still further supposing that plan No. 3 were to be adopted?—Yes, certainly.

2788. Can you give the Committee any idea, from your own observation, as to what becomes of the sand that is carried away from the beach on the north side of the harbour?—What becomes of it ultimately I do not know, but it travels along the coast to the northward.

2789. What takes it to the northward?—The wave action. You have a little tracing here showing the erosion which is going on for some little distance to the north. It shows the progressive annual erosion.

2790. By which you mean that the shore is eaten away?—Yes, northward from a point about a mile from the north pier. For that length of a mile the shore is revetted with stone, so that there is no change, but beyond that it is allowed to wash away, and it cuts in each year a little bit more. I should think that in the last three or four, speaking from my recollection of the plan, from 30 feet to 40 feet per annum of this erosion has continued for a distance of half a mile or three-quarters of a mile. Beyond that there does not seem to be much erosion.

2791. But it is still going on?—Yes. During the north-east monsoon the sand comes back again and fills up nearly, though not quite, to where it was the previous year. The area washed away is, I will not say exactly the same, but it is fairly comparable with the area which has been gained to the south of the harbour. Up to 1884, 88 acres were gained south of the harbour, and 41 were lost north, but one-half of the length north that would be affected is revetted and protected.

2792. (*Chairman.*) During the north-east monsoon you say that the sand is replaced there; is any sand placed on the revetment?—No, it does not extend to the revetment. There has been an eating into the land north of the revetment, and during the north-east monsoon, although it is partially filled up, it is not filled up to the line of the revetment, so that the face of the revetment itself is always clear of sand.

2793. Does the revetment stand well or does it need constant repair?—It needs constant repair, but not to any very great extent. After the great storm of 1881 it required some considerable repairs.

2794. Was that from the sand being eaten away from underneath it, or from the force of the waves striking on it?—I think it was from the force of the waves striking on it and flattening it. The sand may have been drawn away from underneath it, but we do not find that there is any serious increase of depth.

2795. We have had evidence that on the north side of the harbour there is a current following the shore and turning out along the north arm of the harbour. Your experience is that the sand is moved away to the northward?—It is moved away to the northward in the south-west monsoon.

2796. Supposing that current to exist at that side, do you think that there is any danger of silting up the north-east entrance under the protection of the covering arm?—I do not think so. I feel perfectly confident myself that there is no current and there is no force of the wave at Madras that will affect the depth of the entrance in seven or eight fathoms. Ultimately the sand will creep out from the shore on the south side, but that is the only circumstance from which I can anticipate any deterioration of the entrance. I do not think that the current on the north side will have any effect at all. But I may say with regard to that current that there is no current close in shore north of the harbour; it may be deflected out a little, but it is not a current that has any scouring power whatever.

2797. (*Sir John Coode.*) Have you directed your attention particularly to the existence of a current along the back of the north pier?—No, I will not say that I have particularly examined it, but if it had been there I am quite sure that I should have been aware of it.

2798. The pilot has told us distinctly that there is a current there?—I do not think that the pilot knows much about that part; he has no occasion ever to go there.

2799. Does he never take any vessels in there which find anchorage north of the north pier for the discharge of railway material?—I do not think that he has anything whatever to do with that. He knows all about the currents out in the nine fathoms, but I do not know what he has to do with the five fathom depth at all.

2800. You think that he never takes vessels into anchoring ground north of the north pier?—No, I believe not.

2801. Then you think that his duties are entirely confined to taking vessels into and out of the harbour?—Yes. I observe that Captain Taylor suggested that the sand was scoured along the foot of the north pier. We have sections taken of it every 25 feet, and there certainly is no material amount of scour to be found. The only scour of the sand that ever was found was after the storm of 1881 immediately just in the knuckle of the north pier at the foot of the rubble base where the sand was scoured out.

2802. To what extent?—I think you have a plan in which it is laid down.

2803. Could you tell us approximately?—The scour of the bottom by the storm of the 12th of November 1881 taken from the cross-sections (the blue figures represent the amount of scour) was about 8 fathoms. Beginning at the pier head, and going on to the north we come to an accumulation of 2½ feet, then an accumulation of 3 feet, then of 2½ feet, then nothing, then a scour of 2 feet, then nothing, then an accumulation of 1 foot, then nothing, and nothing again, then an accumulation of 2 feet, and an accumulation of 4 feet, and as we approach the knuckle an accumulation of a foot and a half. Then there is no change till we come nearly to the inner tangent of the curve, and then it begins to scour 2½ feet, 3 feet, 7 feet, 5 feet, 8 feet, 3 feet, 2 feet, 3 feet; and continues at about the same rate for 500 or 600 feet towards the shore, beyond which there is no change.

2804. That scour terminating at the inner end of the curve in each case for all practical purposes?—Practically it is so. Then on the south pier there is a little scour even along the straight part, at the extreme end there is 4 feet, 3½ feet, 1 foot, 1 foot, 2 feet, 2 feet, nothing, nothing, nothing, 3½ feet, 2 feet, nothing, 1 foot, 1 foot, 1 foot; then an accumulation of 2 feet, then a scour of 2 feet, then 3 feet, and 2 feet.

2804*a*. This must be some scattered rubble; it is so irregular?—No, it is well out of the rubble. You must remember that those are all in depths of 48 feet. I should be very sorry to swear to these soundings or to the accuracy of them under a foot or so, and after this very great disturbance I do not think that an accumulation of 2 feet in one place and a scour of 2 feet a couple of hundred feet off it, is any very serious matter.

2805. What I cannot understand is the great inequality. I can well understand a portion of the rubble being washed away at one place, and a portion of the depth appearing to shoal at another, but I cannot understand the accumulation of sand and the scour of sand to the extent of 2 feet occurring so close together.—I think that this is at any rate a complete proof that there is no very serious action upon the sand, except in those particular directions where the wave action is really converted into a current for the time being, and not a very heavy current; but on the eastern face of the work, where it is exposed to the sea nearly at a right angle, the action is really nothing serious.

2806. Not in the way of scour?—No, not in the way of scour. These are simply the facts put down as I found them on the sections. I do not think that you can take any two particular ones and argue from those, you must take the general result. I look upon this as a very valuable document.

2807. You say that this is in answer to Captain Taylor?—Yes, it is in answer to Captain Taylor.

2808. (*Chairman.*) Did you put in a calculation as to the cost of plan 3?—No, I had nothing to do with plan 3.

2809. (*Admiral Sir George Nares.*) In connexion with that scour and the north-east monsoon current, is it a dirty water current carrying sand?—I have never heard of its being a dirty water current, but my own personal knowledge of it is not sufficient to enable me say to the contrary. I can mention one fact which appears to have been overlooked by Captain Taylor. I have been this morning reading his evidence and I cannot make it out quite clearly. He seems to say that this discoloured water is very obvious in the south-west monsoon, and the current coming up from the south; that he stated distinctly.

2810. But with blue water inside it?—Yes, with blue water inside. It seemed to me at the time that there was a good deal of confusion in the directions of the currents, but if you have got it clear water there, all I can say is that I cannot account for it. Mr. Horne just now seemed to say that it was clear water always in front of these works, and that is what I should have said also, and I should have said that I can see no reason why it should be anything but clean in the north-east monsoon, but for one reason which I will now explain to you. There is an immense sewer which has its outfall just to the north of the north pier. That sewer goes all round the town of Madras. At a guess, I should say there is three miles of it, or something of that kind, and it makes a circuit and comes out again with another outlet at somewhere about 1,100 yards to the south of the south pier. That sewer takes all the surface drainage of the town, and when a heavy rain comes, although it takes only the surface drainage and no actual sewage, this sewer gets heavily charged and the contents issue out with a very strong current indeed. Since our works were begun that has been increased by an intercepting sewer which is carried all along the shore from the southern outfall of this town sewer and now discharges near the northern outfall of the same sewer.

2811. (*Sir John Coode.*) The fall of that sewer being from the south to the north?—Yes, from the south to the north, so as to bring it in to the clear outfall at the north of the harbour.

2812. The object of that being to prevent the mouth of the sewer being sanded up?—Yes.

2813. And also to prevent the sewage emptying into the harbour?—Yes. When the heavy monsoon rains come both those sewers get very heavily charged and the contents are shot out with very great force, and the whole of this water that is lying to the north of the harbour is converted into pea-soup; that is carried out beyond the limit of the harbour, and there it is taken up by the current flowing from the north to the south, and no doubt causes this appearance of discoloured water for some little distance outside the harbour, then continues its course along to the southward and it leaves a space under the lee of the south pier clear; and that would produce just the effect that Captain Taylor describes.

2814. But the description he gave of that colour was that with a north going current, that is along the line of the face of the work, there was discoloured water, but inside that belt between it and the shore there was clean water?—Mr. Horne rather contradicts that. If that is the fact I cannot account for it, but I could account for it from the north.

2815. (*Admiral Sir George Nares.*) With a north-east entrance would it go into the harbour?—Scarcely. I do not think that the quantity is serious.

2816. (*Sir John Coode.*) Of course it is only under the exceptional circumstances that you have just described?—Yes, only under those exceptional circumstances. Of course every shower of rain, even a very moderate shower, would produce the effect to some extent, but once or twice in the season there are those heavy falls and then of course it is more obvious.

2817. (*Admiral Sir George Nares.*) The pilot led us to suppose that throughout the north-east monsoon the water was discoloured even when there was no rain?—I cannot speak to that of my own knowledge. I have never heard of it before.

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2818. Have you not noticed the water discoloured north of the sewer outfall all along the beach?—I cannot say that I have noticed it, though I cannot say that it might not have been the case; but this is a very certain cause of the discolouring of the water as far as it extends.

2819. (*Sir John Coode.*) The pilot told us that the laterite protection along the shore to the north of the harbour had been very much undermined, he said that the slope was very steep and a great deal of this laterite protection had disappeared; does that consist with your knowledge?—We know that the revetment always will want feeding.

2820. But is the loss of the laterite protection very great?—No, not very great. There is no very serious eating away north of the harbour immediately to the north of the north pier. There is an occasional overflow as there was last November.

2821. (*Admiral Sir George Nares.*) Is no sand carried in to the angle north of the north pier by the northern monsoon?—I will not say none whatever, but perhaps in a north-east monsoon there would be a little more sand there than in a south-west monsoon.

2822. Having once got there how is it ever taken away?—The changes within half a mile north of the north pier are very small indeed, for the sand is cut off by the influence of the northerly drift or sea wave, and the southerly drift hardly reaches so far as that.

2823. (*Sir John Coode.*) How do you account for the great wasting of the shore to the north of the north pier so close down to the root of the pier itself, is that from the wave action or the current?—From the wave action. There is no current there, there cannot be.

2824. The pilot says there is a considerable current along the shore?—There is a great difference between pilots and harbour-masters and engineers about the question of current.

2825. The man has lived there all these years and never been anywhere else?—They talk about the current then without knowing what they mean. To this day they will tell you that the bank to the south of the harbour is formed by the current.

2826. The pilot was very clear to us on two points; first of all that he had actually measured the current by knots along the eastern end of the work. He also stated distinctly that the current along the back of the north pier was equal in velocity to about half that of the current running eastward, and was equal to that running along the face of the work outside the present entrance. He did not say he had measured that, but that he had estimated it; he had measured the one in front of the entrance, and he estimated that along the back of the north pier at about half that along the eastern face of the work?—It is an estimate.

2827. (*Admiral Sir George Nares.*) He also said that the water was too dirty for diving?—At times it is.

2828. What were the times; in the north-east monsoon?—It is very difficult to make out. Upon a sandy shore of course there is sometimes sand washed up and that makes the water thick. When there has been a succession of calm weather for several days there would be less, and then the water gets clear. I think that a great many of the pilot's conclusions were upon matters that really would hardly come within the scope of his observations. He has nothing whatever to do at that part; it is no business of his to go there.

2829. (*Sir John Coode.*) Is there anything else in regard to Captain Taylor's evidence that you would like to offer any remarks upon?—Yes, there are various points which I should like to refer to. I may say that I have not been able to go through it a second time, which I wished to do; but there are one or two points which I should have liked specially to have called your attention to, but I almost think that it would save your time if I were to ask you first of all to let me know whether there are any points on which you would like me to make an observation.

2830. With regard to the rate of advance seaward and the accumulation south of the south pier, have you looked further into that?—Yes, I have looked further

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into it. In the paper* that I gave in, and of which I have a copy, I have ventured to make one or two slight alterations. At the time I drew up this paper, I really had not any idea that any question would be raised about this advance of the sand to the south of the harbour, and therefore I had not looked into it particularly with the latest materials. You asked me to draw up a paper upon the sand movements generally, and with regard to this advance of the sand, I ought to say that I came to the conclusion before I recommended the Government to undertake these works, that it would not be continuing at a rate that would be seriously damaging to the harbour within any reasonable time, and that it really might be put on one side. That was based on general theory, perhaps in the first instance, and then after the first year of our work at the north pier, we got so much data for making a more definite calculation that I was able to test this theory, and I found that if the sand continued to increase annually at the rate that it did during the south-west monsoon of 1876, the four fathom line would take 50 years to get to the end of the knuckle of the harbour wall. This was not taking into account at all the quantity which the north-east monsoon would carry away. The second year we were able to take into account approximately the effect of the north-east monsoon, and that seemed to show that of the area accumulated by the south-west monsoon, about one-half was carried away by the north-east monsoon following, so that approximately (of course it was merely approximately) my calculation of 50 years would be considerably extended, and I assume that for practical purposes we might take it as something like 100 years. Now we have got something like a 10 years' accumulation to deal with, and I made a new basis of calculation which was this, after I drew up this paper, because I had not gone into this matter very much, not thinking that it would come forward at all; but taking the nine and a half years accumulation as a basis, and calculating it upon the same principle supposing it to be filled up annually, and with similar banks increasing in length, breadth, and thickness, it would take something like another 50 years before the four fathom line reached the knuckle of the pier. That is my conclusion at present. It is still subject of course to further correction, but only within very moderate limits. It will take something over 50 years from the present time.

2831. That is extending your original idea?—My original idea, which I never put forward at all prominently, was that it would be 100 years, although it has always been with the understanding that it was only approximate, and that it was liable to correction. In this paper I adopted it almost too hastily, and said that at present one tenth of the space had been filled up. The calculations which I have since made lead me to think that I should like to correct that, and, instead of saying one tenth, say between a sixth and a seventh; and that would leave something over 50 years as the time at which the four fathom line would reach the line of the sea face, and it is at that time that I expect that we might look forward to there being a longshore movement outside the face of the harbour. I do not know whether you have read this paper, but I thought that that correction probably made it advisable for me to give some idea of what would have to be done when that consummation is arrived at, of the sand being in our way.

2832. (*Chairman.*) Before we come to that, the result of your latest calculations is, that it will take another 50 years before the sand fills up the whole of that south side?—Yes, before we need think about it.

2833. (*Admiral Sir George Nares.*) Can you give us a section comparing the actual soundings?—Yes, I could do so, I think. I can show you what it is based upon. I have here a plan, and this plan dated the 31st of March 1886, shows the advance of the shore line every year. To the south of the south pier in March 1877 there had been very little advance. In 1878 and 1879 it advanced according to that section. There are sections through there, and they show that the distance from high-water mark to the four fathom line remains pretty nearly always the same; but always progressing seaward.

2834. (*Sir John Coode.*) You mean that the relative distance between high-water mark and the 4 fathom line always remains the same?—Yes, the slope of the sand at 4 fathoms remains pretty constant.

2835. (*Admiral Sir George Nares.*) What about the 5 and 6 fathoms?—At the 5 and 6 fathoms there is an advance, of course; but I take the 4 fathoms because I consider, and I think I have very good grounds for considering, that in any deeper water than 4 fathoms there will be no along-shore movement of the sand parallel with the sand; within the 4 fathoms I think it is possible, and although it does not appear that it is possible, and although it does not appear that under ordinary circumstances an along-shore movement takes place in a greater depth than 1 fathom, yet I take it that it may do so up to a depth of 4 fathoms.

2836. (*Sir John Coode.*) I do not see what grounds you have for stopping at 4 fathoms and leaving the line there. I agree that it is desirable to take some common standard and that 4 fathoms is a very good depth to take, because it is about the limit of navigation; when you get to less than 4 fathoms it becomes very awkward for navigation?—I took it originally as a perfectly safe limit, and I think it is possibly even more than a safe limit now; it is an excessive limit, for we certainly have ample proof that there is a wave disturbance of the sand in 2 or 3 fathoms, though not an alongshore movement; but we have never seen any evidence of there being any material disturbance of the sand outside 4 fathoms.

2837-42. You do not mean to say that there is not a slope outside 4 fathoms?—Not at all, but simply that that growth outside will not be converted into an alongshore movement as long as the sand does not come within the 4 fathoms. It comes along shore in shallow water, and it is thrown down into deeper water so as to preserve its inclination.

2843. (*Sir John Coode.*) I should like to put before you a statement prepared by this Committee based upon actual soundings supplied by yourself, from which it would appear that the sand accumulation is advancing seaward at the average rate of 80 feet per annum taken over a considerable length of foreshore southward of the south pier, and at the rate of 100 feet per annum near the back of the south pier. Will you give us your views of this statement?—If you will allow me to look over this, I cannot help thinking that I do see where the difference between us lies, but I should like to look it over, and then I will be prepared another day to give you my opinion about it. I have not the slightest doubt about the correctness of these figures; but as for the deduction to be drawn from them I am not so clear, and I should like to look at it before I say anything about it. (*The following statement was handed to the witness.*)

* The Paper here referred to was read by Mr. Parkes to the Committee at their sitting of 22 June. See Q. 2830.

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STATEMENT showing the rate of advance seaward, due to sand accumulation, southward of the South Pier, of the two, three, and four fathoms contour lines, between the years 1879 and 1896. Compiled from soundings on tracings supplied by Mr. Parkes.

The advance of the contour lines from 1878 to 1879 being apparently abnormally great has not been taken into account.

Distance of Lines southward of and parallel to South Pier.	1879 to 1882 (Three Years).		1882 to 1896 (Four Years).		Average Rate of Advance per Annum over Seven Years.
	Total Advance.	Rate per Annum.	Total Advance.	Rate per Annum.	
			TWO FATHOMS CONTOUR.		
	Feet.	Feet.	Feet.	Feet.	Feet.
Feet. 300	200	66	430	108	90
*350	185	62	405	101	84
950	160	53	355	89	73
1,350	230	77	225	56	65
1,750	—	—	—	—	—
	Average advance per annum for four lines	64	Average advance per annum for four lines	88	78
			THREE FATHOMS CONTOUR.		
	Feet.	Feet.	Feet.		
300	215	72	470	118	98
550	220	73	390	97	87
950	245	82	315	79	80
1,350	310	103	220	55	76
1,750	220	73	305	76	75
	Average advance per annum for five lines	80	Average advance per annum for four lines	85	83
			FOUR FATHOMS CONTOUR.		
	Feet.	Feet.	Feet.		
300	300	100	480	120	111
550	240	80	385	96	89
950	305	102	310	78	88
1,350	310	103	260	65	81
1,750	265	88	290	72	79
	Average advance per annum for five lines	94	Average advance per annum for five lines	86	89

* *Note.*—There being no 12 feet sounding on this line in 1883, the position of the 2 fathoms contour line has been estimated for that year.

The general conclusion from the above statement is to the effect that the rate of advance seaward of the sand accumulation cannot be taken at less than 80 feet per annum as an average for a distance of about *one-third of a mile southward of the South Pier.*

It will be seen that the annual rate of advance taken on a line 300 feet southward of the South Pier will be $\frac{90+98+111}{3} = \frac{299}{3} = 99\frac{2}{3}$, practically 100 feet per annum.

The depth on this 300 feet line as far as the present entrance would thus be reduced from 8 fathoms to 4 fathoms in 15⅓ years from September 1886.

2844. (*Chairman.*) We will take your own figures as to the advance of sand on the south side of the harbour. What do you anticipate will be the amount of silting on the inside from the blown sand combined with the discharge into the harbour from the sewers?—The blown sand is a thing which we really cannot calculate upon.

2845. Have you anything to show what it has been during the last two years?—Yes, there has been no material change. I know what has given rise to your question, and I am prepared to give you the facts so far as I know them.

2846. Then you do not corroborate the statement of Captain Taylor that there has been an advance of 100 feet a year during the last two years?—Certainly not, in fact I was summoned rather in a hurry, and I have not it with me; but I have made a sketch showing how it is.

2847. It has also been stated that the water is shoaling at the end of the screw pile pier, two feet?—The fact is that at the end of the screw pile pier the depths are very irregular. I do not know within what period that is alleged; but I can tell you this: that as a rule the depths on the north side of the harbour half-way between the screw pile pier and the north pier have decidedly increased since the harbour was built. Near the south pier there has been some decrease, which decrease is mainly accounted for by the great accumulation of sand that took place when the south pier was being built, in a depth of about two fathoms or between two and three fathoms.

2848. Then you think that the blown sand which, as it banks up on the south side of the pier will increase in quantity, need not be taken into consideration?—I do not think so; it is a very small affair. There would be some, undoubtedly, and if it appeared to be serious I suppose it could be a good deal intercepted by some kind of structure along here (*pointing to the plan*), which would catch it; but, as a matter of fact, I do not think it is at all a serious matter. Then there is another matter which Captain Taylor alluded to, and which Mr.

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Thorowgood has been writing to me a good deal about, and that is the sand coming through the interstices of the blocks. Mr. Thorowgood has told me that that was a serious matter; but he has never been able to give me any figures to prove it, but he sent me some cross-sections which show that for some little distance out this action might be going on, the rubble base on the inside is covered with sand, but as to the decrease of the depth inside, it would take a century to get into the part which is occupied by the shipping; there is no evidence of any result from that whatever.

2849. (*Sir John Coode.*) I may say that the soundings bear that out, and that for all practical purposes the depth is the same now as it was in 1878 and 1879 in the bed of the harbour generally; there is no greater difference between the depths at the two periods than that which would be due to the difference in sounding. The sections also show that Captain Taylor was distinctly wrong when he said that there was a slope of 200 feet. The fact is that the high-water line in November 1886 is nearer the shore than it was in 1882?—That was just after a heavy storm. You are quite right in your conclusion, but the facts will prove this, that the positions of the high-water line in March of each year range over a space of about 180 feet, but they are not further seaward now than they were 10 years ago. The high-water line is not advancing. There was an advance of about 100 feet in 1877, when our south pier works only half intercepted the drift of sand, but there has been no advance whatever since 1877. I do not know whether the Committee would like me to read some papers which I have with me which are rather *a propos* of Captain Taylor's statements, and which, I think, I ought to put in. Captain Taylor, if you remember, said, "It is "obvious to everybody that the pier works have been "subsiding." These papers are *a propos* of that, and either now or at some other time I should like to put them in.

2850. (*Chairman.*) Perhaps you will be good enough to put them in now?—This is from Captain Taylor to the Government of Madras, dated the 15th of April 1885.

"Not having received any official intelligence regarding the reconstruction of the harbour so far as the "distribution of funds is concerned, I can only deal "with the question from the aid of such general information as I have been able to obtain. From this "source I gather that the Imperial Government has "decided to give up all claim to capital and interest "upon the money spent up to the time of the destruction of the walls in November 1881, and throw all "future responsibility upon the trade of the port "through the medium of a trust. It is impossible "to deny that this reads like a very liberal arrangement, though it imposes the liability of all future "mistakes and accidents upon the port, and although "the method of reconstruction is not one that has "found favour in the eyes, or recommended itself to "the intelligence, of those chiefly interested upon the "spot. The chief element of disaster, namely, the "retention of an upright narrow wall on a treacherous "foundation of mud and sand, is still one of the chief "features of the new works, and will, I fear, expose "it to the same risks as its predecessor; while the "eastern opening, by allowing the terrible ground "swell of cyclonic weather to enter freely, and search "alternately every corner of the harbour, will render "the internal arrangements of quays, wharves, docks, "&c. exceedingly costly, and liable to periodic destruction. The gradual settlement of the old walls during "the last three years is a significant fact that I much "fear has escaped the attention of the eminent engineers who have from a distance advised the Secretary of State on this question, so important to Madras. "But it is very palpable to observers here, and my "renewed attention was drawn to it in a marked "manner a few days ago by a distinguished engineer "officer, who makes periodical visits here, and whose "business is directly connected with tides and levels; "he involuntarily started when he looked from my "office on to the harbour, and declared he did not "know the place again, almost every vestige of the "well-remembered broken walls having vanished. I "need hardly say that such a settlement would not "interfere with the rough block construction advocated "by the Madras committee, but is almost sure to prove "fatal to a perpendicular wall pressed upon by an "enormous mass of concrete heavier far than water "and not allowing any recovery after any shock from "sea or storm."

Then he goes on to explanations which I need not trouble you with now. This came, I believe, rather accidentally into Mr. Thorowgood's hands, and he thought it right to inform the Government about it. He says, "Captain Taylor very summarily disposes of "the cause of the damage in November 1881 by stating "that 'the chief element of disaster, viz., the retention "'of an upright narrow wall on a treacherous foun-"'dation of mud and sand, is still one of the chief "'features of the new works.'

"Without again going into the much discussed question of the cause of the damage in 1881, I most "certainly maintain that it is not proposed to build "simply an upright narrow wall on a treacherous "foundation of mud and sand. Indeed I may safely "assert that I would not undertake any work under "such conditions.

"The bottom of the sea near Madras is well known to "be hard compact sand, as is the sea bottom at numberless other sites for artificial marine engineering "works. In the immediate neighbourhood of the town "of Madras there is often a thin layer of muddy slime, "through which a diver sinks with his own weight, "and to a depth of from 2 inches to 15 inches. I "can hardly think that it is this natural sea bottom "which Captain Taylor refers to as the foundation of "the new works. If it be so, I must, with all deference, "be allowed to correct him.

"The new work of the Madras harbour is founded "upon nothing but good granite from Pallavaram "hills, with here and there pieces of old concrete "blocks nearly as hard as granite itself, the whole "of the foundation which is to receive the superstructure being compressed as described in Mr. "Parkes' letter with G.O. No. 3127 W. of 19th December 1884, paragraph 17.

"I append with a plan showing the damaged portions of the piers a section of the new work as "designed, and now in part carried out, which although "it is only a copy of the section of the Government "order above quoted, will serve to refresh the memory, "and to show that Captain Taylor's description that "'the chief feature of the work is an upright narrow "'wall founded on mud and sand,' is not strictly "accurate, while it may be damaging to the reputation of the work, coming from so high an authority "as the master attendant.

"The second point which in positive terms Captain "Taylor urges, is the gradual settlement of the present "remaining portions of the harbour piers, which settlement, he fears, has not been reported in London to "the Engineer-in-Chief.

"It is hardly necessary to point out that all questions of the apparent height or level of any object "must be always a matter of opinion until actual "measurements of feet and inches are brought to bear "on the object, and a positive fact is recorded. It is "most difficult to guess at any level with any degree "of accuracy. To guess at the comparative levels of "some 4,700 lineal feet of more or less irregular "concrete block work under any conditions would be "a dangerous experiment; but when the normal "plane which one's eye unavoidably uses (that is the "level of the sea) as a criterion itself varies three or "four feet in height in every 12 hours, the experiment "is rendered much more liable to error.

"At the end of the ruined work of the north pierhead at high water the top of the blocks is 3 feet "and 10 inches out of water, and at low water 7 feet "and 1 inch out of water. At one of the isolated "portions of the south pier the top of the blocks is only "2 feet 9 inches out of water at high water, and at "low water 6 feet is visible.

"Unless Captain Taylor and his companion in observations very carefully compared the state of the "tide at each observation, it would be perfectly impossible to pronounce whether the blocks had settled "or not.

"Fortunately, the harbour works staff in the plainest "course of duty have kept up records, surveys, and "levels of the blocks since November 1881 to the "present time. Each block is thoroughly well known, "and frequently examined, levels are frequently taken "and distances checked. The plan submitted herewith is a correct representation of the outer portion "of the piers as in November 1881, and with a very "trifling exception it represents the piers now as they "would be at low water." (That is the plan which you have just been looking at.)

"I am not now putting forward any guess made at "random, but am stating an absolute fact, as proved "by surveying, levelling, and observation, when I "assure Government that the blocks in the harbour "pier have not settled two inches since the storm of "November 1881. I have but recently tested the "levels and examined the broken walls, and there is "no appreciable difference whatever in the state of "affairs now and in November 1881; but in taking "levels on such work one cannot positively swear to "2 inches, so I confine my statement to the fact that "there is not 2 inches of settlement. Further, I have "in my possession evidence which shows, without the "shadow of a doubt, that even to an ordinary observer "there is not even any apparent difference such as "alarmed Captain Taylor and his companion. I have "three photographs taken a few days after the damage "occurred, and by comparing these (at half tide level) "with the present scene at half tide level no difference "will be observable."

That *is a pretty flat contradiction of what Captain* Taylor said, *and only a few days ago he repeated the statement*, that the work *is subsiding. This plan (producing the same)* shows the position of all the blocks and as a matter of fact there has been no change whatever since 1881, with the exception that in May last year a piece of the wall was knocked down. How it stood so long no one knows. That is the only change, and so far as we know there has been no settlement. This plan (*producing another plan*) was made in 1879, to show the system of moorings that was then proposed, and for which we had the materials on the ground; and we had began to put down some of those screw moorings when the storm came and put a stop to it. But this plan was approved by Captain Taylor. In fact, I have somewhere a sheet similar to this, with his name upon it, approving it, which I am sure was after the storm, showing that he still approved of it. (*The witness described the plan to the Committee.*)

The witness withdrew.

Adjourned to to-morrow at 11 o'clock.

At the Board of Trade, Whitehall.

Wednesday, 29th June 1887.

PRESENT

Vice-Admiral Sir Nowell Salmon, V.C., K.C.B., in the Chair.

Rear-Admiral Sir George Nares, K.C.B.

Sir John Coode, K.C.M.G. | Mr. F. C. Thompson (India Office), *Secretary*.

Mr. William Parkes, C.E., further examined.

2851. (*Chairman.*) Have you looked over those calculations which were given to you by the Committee yesterday?—I have, and I think that I have discovered where the discrepancy between the Committee and myself exists. It is my own fault, to a certain extent, because I supplied the Committee with what turned out to be rather imperfect data, for these data, as a matter of fact, do not exist in a complete form upon these charts, and I had no idea that they were going to be put to this particular use, or else I would have given what is necessary before. The point is this, that that survey of Mr. Thorowgood in 1886 was made in a very exceptional state of things; it was made after a heavy May cyclone, which we had not before experienced. The survey was really made in the month of September, but there had been no rough weather at all between the May cyclone and the time of the survey, so that the survey really showed with reference to the deeper contours the results of the heavy sea of May. The Committee has taken perfectly rightly the advance of the contour at 2 fathoms, 3 fathoms, and 4 fathoms from 1879 to 1882, and again from 1882 to 1886. It is quite correct that those three cases of advances of 2 fathoms, 3 fathoms, and 4 fathoms are elements in the question; but there are other elements which do not appear in the calculation, and when they are brought in a very different result is produced. Those elements are the advances of the contours at a less depth than 2 fathoms, that is, at 1 fathom, as datum level, and at the top of the accumulation which is about 6 feet above datum.

2852. (*Sir John Coode.*) I think it is only right to point out that the comparative statement only commences with the year 1879, when the works were out to the knuckle?—I am following that now. I have not gone back to the previous date. These calculations show the advances at the three levels; but there is a large amount of material which is being dealt with by the sea above that, and in order to get at the average amount of advance we must take that upper part into consideration.

2853. (*Chairman.*) In what way?—We should take it into the calculation, and combine it with the amount of advance in the three lower contours.

2854. When you speak of combining them, of course, so far as the general slope is concerned, it is combined; but any exceptional increase or reduction of the sand inside the 2 fathom does not affect the bank increasing outside the 2 fathoms, and cannot by any means affect the general question?—I think, perhaps, we are rather going upon a different question. The question that I have been going into is simply a calculation of the quantity of sand.

2855. Probably you will confine yourself to the question of the advance of the sand as affecting the south arm of the breakwater, that is to say, the time that, according to the present data, will be taken in filling up that corner with sand?—That is just what I am going to do.

2856. (*Sir John Coode.*) Only I should like to make the remark that up to yesterday your own standard has always been the 4-fathom line?—Yes, and I take the standard of the 4-fathom line still.

2857. I understand that you take exception to every-thing below your 3 or 4 fathom line?—No, not to the 3-fathom line; I merely want it combined with the effects which I find at the 2, 3, and 4 fathoms. I accept these, but I wish to combine with them the effects produced at 1 fathom, as datum, and at 6 feet above datum, and I will show you why that is necessary. Upon this plan before me, which is a plan of September 1886, showing the high-water marks, it appears that instead of the high water advancing from March to May, and, again, on to September, as is always had done in every year previously, it actually retreated at the time of the storm, in round numbers, say, 100 feet between March and May last year. The sand that was clawed down in the month of May must be found somewhere, and it is found upon those contours; but, at any rate, instead of finding a considerable decrease at these upper levels, we find a considerable decrease between March and May. It seems to me, then, that what we have to do is to combine with these advances, of the 2, 3, and 4 fathoms, the effects produced at these upper contours, and we cannot get that by any direct survey; but we can get it indirectly in this way:—I take the position of the high-water line in May 1882, which is a little in advance of what it was in March 1882. I then measure the distance from May 1882 to May 1886 to the positions of the several sections, and I put that down.

2858. (*Chairman.*) That is to say, you are measuring the high-water mark?—Yes. Now, the distances of the advance of high-water mark will be within a very little the same thing as the advance of the datum contour, and the advance at the top of the bank 6 feet above datum. So that my process is to put in those two advances and bring them into the average. The

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1 fathom I cannot get; but I do not think that it is of any very great consequence, because inasmuch as the 2 fathoms is abnormal in one direction, and the datum line is abnormal in the other direction, we may assume that the 1-fathom line will not be very far from the normal, so that we may leave it out without any material error. Therefore I have taken here five values for the advances, at 4 fathoms, at 3 fathoms, and at 2 fathoms; then I leave out the 1 fathom, and I take the advance at the datum line, and the advance at 6 feet above datum. I find that that datum line, assuming it to be the same as high-water mark, and it cannot be much wrong, advanced 123 feet per annum, between 1879 and 1882, and 49 feet per annum between 1882 and 1886; and at the 6 feet above datum they are the same values, and, when I add all these in together, the mean result is that the annual advance from 1879 to 1882 is 97 feet, and the mean advance from 1882 to 1886 is 71 feet.

2859. Up to the present, you are merely giving us the high-water mark?—No; excuse me, I am giving you the depths down to 4 fathoms, only taking into account the sand that lies above the 2-fathom level as well as that which is below. (*Witness handed in the following statement:*—

"MADRAS HARBOUR.

"Statement shewing the rate of advance seaward due to sand accumulation south of the South Pier, at the top of the slope, at the datum contour, and at the two, three, and four fathom contour lines, between the years 1879 and 1886.

"The advances of the two, three, and four fathom lines are those measured for the Committee from charts supplied by me.

"The advances of the top of the slope and of the datum contour are supposed to be the same as those of high-water line, which is intermediate between the two. The high-water lines adopted for comparison of 1879 and 1882 are those of March in each year. Those for comparison of 1882 and 1886 are for May of each year, that for 1886 being from actual survey, and that for 1882 (in which year the May high water was not recorded), being represented by a line in the same relative position to that of March 1882 as the May line of 1883 was to the March line of 1883. It is assumed that the advance of the one-fathom line, of which there are no records, may be omitted without material error."

Distance of Lines southward of and parallel to South Pier.	1879 to 1882 (3 years).			1882 to 1886 (4 years).		
	Total Advance.	Rate per Annum.	Average Rate per Annum.	Total Advance.	Rate per Annum.	Average Rate per Annum.
			Top of Slope Contour.			
Ft.	Ft.	Ft.		Ft.	Ft.	
300	400	133		210	53	
550	400	133		220	55	
950	390	130		180	45	
1,350	340	113		190	48	
1,750	310	103		180	45	
			Ft.			Ft.
			123			49
			Datum Contour.			
			Ft.			Ft.
	Same as above.		123		"	49
			Two Fathoms Contour.			
Ft.	Ft.	Ft.		Ft.	Ft.	
300	200	66		420	105	
550	185	62		405	101	
950	160	53		355	89	
1,350	230	77		225	56	
			Ft.			Ft.
			64			88
			Three Fathoms Contour.			
Ft.	Ft.	Ft.		Ft.	Ft.	
300	215	72		470	118	
550	220	73		390	97	
950	245	82		315	79	
1,350	310	103		220	55	
1,750	220	73		305	76	
			Ft.			Ft.
			80			85
			Four Fathoms Contour.			
Ft.	Ft.	Ft.		Ft.	Ft.	
350	300	100		480	120	
550	240	80		385	96	
950	305	102		310	78	
1,350	310	103		260	65	
1,750	265	88		290	72	
			Ft.			Ft.
			94			86
General average			97			71

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The general conclusion from the above is that the increased advance shown in the two and three fathom contours is due to sand which was drawn down from the shore by the exceptional sea action of May 1886, causing the abnormal erosion of the shore line, which is shown by the plans, and is not due to any increase in the quantity of sand accumulated. The ordinary accumulative action of the S.W. monsoon of 1886 partially filled up this void, and the present, and possibly next year's, monsoon will probably complete the restoration of the ordinary slope between the advancing shore and the present two-fathom line before the latter makes a further advance. The exceptional action will have done nothing to accelerate the general rate of advance towards the head of the pier.

W. PARKES,

1st July 1887.

2860. (*Sir John Coode.*) So that, as I now understand you to say, it really is a question of the growth of the beach between the high-water line and the 2-fathom depth; if the 2, 3, and 4 fathom lines are advanced, what does it matter as to the particular inclination of the slope of the beach between 2 fathoms and high water? Your own standard hitherto has been 4 fathoms, which I thought was a very proper one?—I have not touched the 4 fathoms in the slightest degree; but I think you hardly appreciate yet the line upon which I have been going. I do not reject anything in this survey. All these figures are taken religiously from the survey, and from nothing else; but if you say this may happen again and throw us out, my reply is this: that all that this cyclone has done has been to flatten the slope.

2861. (*Chairman.*) So far as the objects of this Committee are concerned the only thing we are concerned to know is that the sand is rapidly growing up; it is of very little moment whether that sand is brought down from above high-water mark and produces shoal water where the entrance has been proposed, or whether it is brought in from the sea, or where it comes from; but you do not contest the fact that the line is steadily advancing?—Not at all; I quite admit that; it is simply the rate of advance that I am contesting.

2862. (*Admiral Sir George Nares.*) If you couple the whole of those years together it comes to 82 feet?—Yes, it comes to 82 feet, spread over seven years. I quite admit that; but then I say that in the next seven years it will not advance at the rate of 82 feet a year. That has been the principle which I have gone upon, and those calculations were produced to show that this survey is not inconsistent with my supposition. I call it a supposition for want of a better word; but I really think it is an established fact, as I shall be able to show you. My principle is, that every year there is a layer of sand deposited upon this slope; but inasmuch as that layer covers a larger area every year, being longer and deeper, its thickness will be less every year.

2863. (*Chairman.*) That seems to be rather arguing from the point of view that only a certain amount of sand is in motion, forgetting the fact, that if it had a larger surface to collect and deposit, there can be no doubt that there is a further sand also to be collected?—Excuse me, I think that is rather anticipating my conclusion, or in opposition to my conclusion, because what I want to put before you now is, that although in the first instance this may have been a supposition, yet that the experience of ten years has shown that there is no other source for this sand but the inshore movement from the southward; it cannot come from anywhere else.

2864. (*Sir John Coode.*) Just for the moment you had better put aside the question of the origin of the sand. What we are dealing with is the rate of advance?—I really am going to the rate of advance; but my point is this: that this annual layer that is being deposited there, assuming that the same quantity is brought every year, must of necessity get less and less. Perhaps that assumption would have been rather a bold one in the first instance; but I think now our ten years' experience has so fully confirmed it, that we may adopt it as a conclusion. For a moment I confess I was staggered by those figures; but when I look into the figures, and treat them in that way, the figures confirm my conclusion.

2865. I understand that the figures which you have prepared are virtually a corroboration of the figures in your statement; that is to say, that below the 2-fathom line, which is what we have to deal with as available for navigation, the rate of progress is substantially the same as the Committee's statement?—I have taken them as the same.

2866. Then that point purely concerns your own standard of the 4-fathom line, and the rate at which it is advancing?—I do not touch the question of the 4-fathom line; what I say is, that up to the 4-fathom line there will be a certain quantity of sand, and if you measure what has been done in the way of accumulating sand in the last four years, you must take into account not only the accumulation at the 2 fathoms, but the accumulations at the other depths.

2867. (*Admiral Sir George Nares.*) Your argument is that the face of the beach has attained its normal inclination to the strike of the sea already, and it will never alter again?—That is my assumption, that it will never do so permanently. My assumption is, that the facts which I see here in the records of ten years show so clearly that that is the result, that we are safe in assuming that it will continue so. There may be an occasional exception, as the year 1886 was; but it is evident now that the line is recovering itself, and in a year or two there will be no remains of that disturbance.

2868. Are there no observations obtainable by which we can arrive at the fact that the face of the beach has attained its normal inclination?—I put that sketch forward as as strong a proof as I can imagine.

2869. Not for half a mile or a mile south of the harbour?—It runs out south until it joins the original line of the shore.

2870. The original line of the shore is what distance south?—To a certain multiple of that basis. I do not say what multiple it is, but it remains the same multiple, if it is a slope of 1 in 6, that is 600 feet off, if it is 1 in 5, it is 1,000 feet off. I think that is a reasonable idea for one's mind to begin with, and that fully confirms my argument.

2871. (*Sir John Coode.*) Are there any facts available to warrant the statement that you have now made, that is, that the exceptional state of things is being done away with?—Yes.

2872. I cannot quite see how, because the last standard is September 1886, and September 1887 has not arrived, and you must compare like things with like; you must compare the beach always at the same season?—We have September 1886, and it had then partially recovered itself; it had got beyond what it was in March.

2873. Are you speaking of the high-water line?—Yes.

2874. We know perfectly well that the line of sand, like the high-water line, varies from week to week, if not from day to day; and therefore, taking the standard of high-water line, I am afraid is hardly a safe gauge?—I think if you come to look into it, you will see that it is representative of the whole of the facts. There will be exceptional cases every now and then. It takes time for the slope to recover itself, but that it will recover itself I have not the slightest doubt.

2875. Would you be prepared to take the distance of high-water line from the shore as a standard, and by that to judge the whole question of the accumulation of sand?—I should have considerable hesitation in doing so, if I had not the facts to support it; but I think I have the facts now, one important fact being that for ten years we have failed to discover that the sand is coming from any quarter whatever except along shore during the one monsoon, and partly moved back again by the other. All the abrupt projection into the offing has produced no result, or next to no result, upon the bottom outside.

2876. It may have produced no result upon the bottom outside; but between it and the shore it has?—Yes, undoubtedly every contour has advanced there.

2877. I do not agree with that, but of course the two go together?—From the forces re-acting continually the effect of those forces is to produce a certain slope.

2878. Bear in mind that the surf on the beach varies and the slope just above and below high-water line varies with the surf from day to day; whereas the deep lines, the 3-fathom and 4-fathom lines are not influenced unless on exceptional occasions?—Just so, that is my point, that they are not influenced; but, as a matter of fact, taking all the year round the result is a very regular but decreasing rate of advance; that is no longer a supposition, it is a fact.

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2879. Not in deep water surely?—No. In deep water I admit that the effect of a violent cyclone like that of last May remains until another cyclone comes, which may alter it a little, or until the slope formed by the cyclone is swallowed up in the advancing sand.

2880. Do you mean that remark to apply to the depths outside the 2-fathom line, or between the 2-fathom and the beach line?—Outside the two fathoms I do not think that there is any effect produced, except by very heavy weather, until the slope from the shore line advances and lips over as it were.

2881. (*Chairman.*) It rather appears to me from your argument, that you contest the accuracy of the soundings which you yourself laid before us?—No, not at all. I accept everything. My calculation here is based entirely upon those soundings, so far as they go, and I only took it up from the place where the soundings fail because they were not made. Above the water, of course, we do not deal with soundings, and in one fathom deep we cannot take soundings on account of the surf.

2882. In spite of what the soundings show to be a steady increase in the sand to the south of the pier, you tell us the increase will not go on at the same ratio?—It will go on in a decreasing ratio.

2883. And the time which you calculate will be taken by this sand to fill up that corner is how many years?—Something over 50 years before the 4-fathom line reaches that corner.

2884. You mean the advance of the 4-fathom line?—Yes, of the 4-fathom line and the 2 and 3 fathom lines. I do not object to anything in your paper here, except that it is incomplete.

2885. (*Sir John Coode.*) Because it does not include the portion between high-water line and the 2-fathoms depth?—Which are necessary to the calculation of the total quantity of sand that has been brought along the coast.

2886. But if it shows that the 2, 3, and 4-fathom lines are advancing in the ratio you stated, does it affect the question at all materially as to what may be the slope of the entire beach between the 2-fathom line and high water?—Most materially it does.

2887. But you yourself have taken the 4-fathom line as the standard also, and you say that the 2, 3, and 4 fathom lines you do not question at all?—No, but my argument is this: that the constant annual quantity that we have to deal with is the quantity of sand, so many cubic yards per annum, which is deposited in that bay. Different circumstances of weather may vary the distribution of that sand, but the quantity of it remains the same or approximately the same. After a heavy cyclone in one direction it may be steeper, and after a heavy cyclone in another direction it may be flatter. But, taking a series of years in which those irregularities are equalized, we find that the result is a uniformly decreasing ratio of advance.

2888. What we, as a Committee, have to deal with is really not so much the cubic quantity, as the rate of advance and the growth of the sand; because the cubic quantity will depend upon the angle made between the solid breakwater and the shore; and, therefore, what we have to deal with, putting aside the question of the cubical quantity, is what is the rate of advance seawards of the accumulation?—I meant to say that the angle formed in-shore is a constant angle.

2889. (*Admiral Sir George Nares.*) If the 4-fathom line continues to advance at its present rate, will it reach the end of the harbour in less than 20 years?—Taking its present rate as the rate from the beginning, and making allowance for the decreasing ratio, it would.

2890. Not making allowance for the decreasing ratio?—Taking your question literally, it is simply a question of multiplication, and no doubt it would. I do not take it so; I cannot admit the condition.

2891. We have no observations between half a mile and a mile south of the harbour, which will show that the accumulation of sand there is altering much?—You mean to say to show that it is accumulating there.

2892. I mean as a proof that the natural inclination has attained its normal position?—You think that this is not sufficient; that it might be much farther south.

2893. The observations go to 1,750 feet; have we any observations farther south?—Yes, I have, but those soundings on the plan go considerably beyond that, and I could carry these on very considerably farther if it were desired. I hope you will consider that, because I really do feel very strongly convinced myself of its soundness. It is not a matter which I have taken up in a hurry; as you know it has been very much in my thoughts now for many years and everything has confirmed the principle.

2894. (*Sir John Coode.*) What I would impress upon you is, that it is not the cubic quantity that we have to deal with; but the rate of advance?—But the rate of advance depends upon the cubic quantity.

2895. I am taking the facts of the investigation upon such data as we have over the last seven years?—It appears to me that all that does depend upon the quantity of the accumulation. It is merely the different disposition of the particles of sand under different influences; but the quantity remains the same. May I ask whether you have any sort of suspicion that the sand does come from any other quarter than along shore.

2896. (*Admiral Sir George Nares.*) There is a knuckle at the south-east end where we have a very strong suspicion that it does come from?—I should think so to some little extent, but that really is one of my strong points. I find that the land is accumulating to the south of the harbour; it is accumulating year by year; and I find at, approximately, the same rate it is diminishing year by year in the north of the harbour. That seems to me a very strong argument in favour of the supply being brought by an along-shore movement and nothing else.

2897. (*Sir John Coode.*) But the shore to the north is revetted for about a mile?—Yes, it is, and allowance must be made for that.

2898. Then, also, I understood you to say yesterday that the portion of the sand which was shaved away north of the revetment during one portion of the year was grown up again afterwards?—A portion of it year by year. There is an erosion. This plan will show it for several years (*producing a plan, and explaining the same*).

2899. (*Admiral Sir George Nares.*) If the sand accumulates at a certain part of the year north of the revetment, why does it stop there. The current from the north in a north monsoon carries sand with it, which is deposited north of the revetment?—Yes.

2900. Does discoloured water get there, and does not it continue along by the side of the revetment?—There is no question, so far as I know, of discoloured water. It is not the current action which brings it; it is simply wave action.

2901-2. But the wave action is accompanied by current?—It may or may not be, but the current, so far as I can make out, has no effect whatever upon the movement of the sand; it is entirely wave action, so far as I can make out, within a depth of one fathom.

2903. Then, why does it stop at the revetment?—Because there is a bay north of the revetment to fill up. There is not sand enough coming down to do more than that.

2904. What became of the groynes north of the harbour?—They were washed away. I daresay the material of them might be found a little way from the shore.

2905. When they existed, did any sand collect on the north side of them with the northerly monsoon?—Yes, it did to some extent; but they were never completely full, and they never answered very well as groynes. The northerly drift does not seem to be intercepted by groynes to a great extent.

2906. What I want you to tell me is, the movement of the sand, where the groynes were at that time?—Before the harbour was made, those groynes intercepted the sand from the southward.

2907. Not from the north?—There was only a little accumulation when the drift was from the north.

2908. (*Sir John Coode.*) Then from that we may conclude that the sand coming from the north is but very limited in quantity?—It is very much less than what comes from the southward.

2909. (*Admiral Sir George Nares.*) Have you studied the question of the Pulicat and Armaghan Shoals?—No, I have not.

2910. Do you know what keeps the channel open between them and the shore?—I do not know that. I do not know the place. But I should like, with reference to that, to read what Captain Taylor says about it. He says that there is an accumulation of sand there.

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2911. No, he said there was a channel kept free between them and the shore?—I should like to know exactly what is the state of things there.

2912. (*Chairman.*) General Sankey, in his evidence, considers that such a sand advance along the south face of the harbour sufficiently far and sufficiently fast to endanger the entrance to the south-east corner, may be easily arrested by putting rough stone groynes along the shore to the southward compelling the sand to deposit itself at any point required; what is your opinion with regard to that?—I agree with General Sankey in that. Of course it will cost money; but I can give you an estimate of the annual cost, and I have put it into a memorandum, which I appended to my paper on the land movement, of which the Committee has a copy. If you will allow me, I will read it: I say, "It may be "desirable to indicate what would be the cost of "intercepting the movement of the sand from the "southward, if it were desirable to do it under "present conditions, and it may be assumed that if it "became necessary to do so 50 years hence, the cost "would be in the same proportion to the conditions of "the period. In 1877, the movement of sand was "actually intercepted at the South Pier, and this "operation might be repeated at any time and in any "part of the beach, in the same manner, with about "the same quantity of stone and at about the same "cost. It required about 33,000 tons of stone, and the "cost was about 66,000 rupees. This cost would "have to be incurred annually by forming groynes "at successive intervals along the beach, and, by a "judicious arrangement of the groynes, land would "be gained which might be valuable."

2913. (*Admiral Sir George Nares.*) Do you say how many feet you advance the groyne each year?—It would be about 700 feet of groyning, and every year all along the groyne there would be about 700 feet advance from the high-water mark of that year.

2914. (*Chairman.*) Is all this work on one groyne, or is it on a series of groynes?—That is a question that may arise. My own personal experience is of only one groyne. One groyne of that length, or something like that length, will arrest a year's accumulation, and next year another groyne would do the same at another point.

2915. (*Admiral Sir George Nares.*) How far south?—It can be put anywhere.

2916. In 50 years' time, how far down the coast would you advance with those groynes?—I should advance one beyond the other; but I should not make a series of groynes 700 feet long from the high-water mark.

2917. (*Sir John Coode.*) You mean to say that the united growth of several groynes year by year would amount to 700 feet?—One year's growth would require 700 feet of groyne to arrest it.

2918. The equivalent of 700 feet to one groyne?—Yes.

2919. (*Admiral Sir George Nares.*) But the next year you would not want 700 feet beyond that again?—No, not 700 feet beyond that. My point is this, that when the present harbour is threatened with silting by the advance of the sand, at a certain annual cost it can be kept clear.

2920. And it would be saddled with an annual cost of 66,000 rupees besides its ordinary maintenance?—Yes, with an additional cost, which would be 4½ annas per ton of cargo at the present rate of trade.

2921. (*Chairman.*) To this annual expenditure, there is absolutely no finality?—There is no finality; we cannot anticipate it, but it is very far removed from that at present.

2922. What I mean is, that no one, two, three, four, or even ten groynes of a certain length will suffice to make the harbour safe from an accumulation of sand for ever?—No. I have always, from the very beginning, thought that supplementary works will be required whenever the sand does advance, but that the time at which they will be required is so distant that we need not take it into account. But I may just mention that an alternative to those annual groynes would be another pier similar to the present one run out to about the same extent. It would take between 60 and 70 years, according to my calculation, to fill up, and the interest upon the cost of that would be about the same as making annual groynes.

2923. (*Admiral Sir George Nares.*) What groynes are being constructed south of the harbour now?—I saw that Captain Taylor mentioned that one groyne had been made at the mouth of the Coom. I do not think that he quite explained the state of affairs at the Coom; but the Coom is a river which comes round at the back of Madras and discharges itself some little distance to the south of Fort George, and during a south-west monsoon the mouth of the Coom is completely closed by the drift of sand across it. Generally, with the rains of the north-east monsoon and the consequent floods in the Coom, that bank is burst open. Sometimes, the floods are not sufficient to do that. The first time I was at Madras in 1873, it never opened. Sometimes it is nearly open, and then they help it by casting out the sand. But lately, since I have been at Madras, I imagine, from what Captain Taylor said, they have attempted to keep this opening permanent by a groyne on the south side of it, which he seemed to say was 150 feet long. If so, I feel pretty certain that it is insufficient. He seems to think that it is on the wrong side, but I do not know what are his grounds for thinking so.

2924. A large groyne in that position would benefit the Madras Harbour Works, would it not?—Yes, it would prevent the sand coming up to the harbour.

2925. By catching the sand south of the harbour?—Yes. It is quite evident that no sand has ever been stopped yet, because there has been no falling off at all in the rate of accumulation. Captain Taylor talks of there having been no advance for the last two years, the fact being that there was this absolutely exceptional retreat in the month of May 1866, which, probably, he did not attribute to an exceptional cause.

2926. (*Sir John Coode.*) Captain Taylor only judges from what he sees above the water?—Yes.

2927. Whereas the Committee are judging by soundings?—Yes. I have no doubt whatever about it, that the cause of that accumulation in 1886 was just as great as it was in 1885, but it was differently distributed.

2928. (*Chairman.*) With reference to the wall that you mentioned just now, how far would you propose to construct it from the present one?—I have not gone into details of that kind. It might be placed anywhere at any reasonable distance from Madras; but what I look forward to is that, if that plan be adopted, it would be made a part of some general plan of extension of the harbour which at that date would probably be required.

2929. Is there anything in that paper which you have submitted that has not come out in evidence?—Yes, there are a good many facts which I consider important.

2930. Will you be good enough to read it to the Committee?—"*Notes on the Movement of Sand in and near the Harbour, by W. Parkes, M. Inst. C.E., May* "1887."

"1. The sand question at Madras naturally divides itself into two parts: the movements (if any) outside the limits of surf-action, and those within those limits.

"2. These were both made the subject of investigation in the course of the preparation for the design of the harbour; but the local materials for forming conclusions were very meagre, and all that could be done was to allow ample margin for unexpected results.

"3. With regard to the movement of sand outside the limits of surf-action, the evidence was almost entirely negative. There was no record of any changes in depths in the roadstead (7 to 9 fathoms), and no adequate causes could be suggested why there should have been any change, or why the projection of solid piers out to the 7-fathom contour should produce any change in the conditions of permanency.

"4. It would be useless to detail the nature of the various *a priori* arguments for and against this conclusion. The conclusion itself has been brought to the test of experience, which I will now proceed to describe."

2931. (*Admiral Sir George Nares.*) Was there no evidence with regard to the anchors sunk at the bottom?—Yes, there was.

2932. And of the movement of the sand in connexion with them, irrespective of the change of depth?—The fact which you remind me of now, and which I was

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informed of at that time, was that outside the 7 fathoms anchors were never buried in sand. I forget now whether it was 6 or 7 fathoms, but we may take it at 7 fathoms, but that inside of that they were occasionally buried in sand, and sometimes they came out again. There was a movement of sand in these lesser depths, but none whatever was known outside.

2933. Even if they did not get buried, nobody can say anything with regard to the sand being carried north or south without burying?—No, there was no evidence upon that point.

2934. (*Chairman.*) Excepting the evidence of the groynes then in existence?—That is on the shore. I am now talking of deep water, from 7 to 9 fathoms. I am coming to the shore movements presently which are quite distinct from that:—

"5. The construction of the harbour was finally sanctioned by the Secretary of State in March 1876, and in April following I visited Madras, and made certain arrangements for commencing the works, among which was a recommendation that a detailed marine survey of the coast and roadstead should be made as a record of their then state.

"6. This recommendation was not acted on till the following year, when Messrs. Jarrad and Falle, of the Marine Survey Department, were deputed for the service, and during the Autumn of that year they made a very complete chart.

"7. The works had been commenced in January 1876, but they had been carried only about 700 feet out of the 3,300 feet, which was the distance to the 7-fathom line, so that so far as the roadstead was concerned no effect could have been produced.

"8. I was myself at Madras from October 1876 to January 1877. The survey was then finished, but not plotted, and I did not receive a copy till after my return to England.

"9. In February 1878, Messrs. Thorowgood and Beardmore made a survey, but this only extended to 7 fathoms, and is, therefore, not available for comparison with the previous surveys in the greater depths. By a comparison of so much of the area as was covered by both surveys, however, it appeared that there was a difference of about 3 feet in the whole of the depths figured on them. Of this, 1 foot 1½ inch was due to the former depths having been referred to low water, while the latter were referred to the datum adopted for the harbour works (De Haviland's mean sea level). Thus there was a difference of nearly 2 feet not accounted for.

"10. Every attempt was made to discover the cause of this discrepancy, but without success, and we were reluctantly driven to the conclusion that while the survey of Jarrad and Falle was valuable in showing the general character of the bottom, it could not be taken as a basis for a comparison of depths with the surveys made by the officers of the harbour works staff."

2935. (*Admiral Sir George Nares.*) In what direction was the variation?—There was a variation of 3 feet less.

2936. The later survey showed a greater depth of water?—Yes, greater depth of water, of which rather over 1 foot, is accounted for by the difference in the datum:—

"11. In October 1878 another survey was made, but in this, though some soundings were taken further out than in the February previous, they are too few to give a satisfactory record.

"12. In September 1879, however, a very complete survey was made, with which all subsequent surveys can be well compared. At the date of that survey the harbour works had made some progress, and the question, of course, arises how far the state of the bottom shown at that date may have been due to the changes of condition produced by the advance of the works towards deep water.

"13. There is no direct answer to that question, but I think subsequent surveys give an indirect one. The three accompanying sketches show the state of the works in October 1876 (Jarrad and Falle), September 1879, and September 1882. The change of conditions due to the advance of the harbour works from 1879 to 1882 is greater than from 1876 to 1879, and in that interval also occurred the heaviest sea that had occurred since the commencement of the works. Yet in this period there is no appreciable change in the state of the bottom from the 6-fathom line outwards."

"From this it may surely be concluded that the smaller change in the state of the works and the absence of any extraordinary wave disturbance during the earlier period would not have produced any important change in the bottom between the outer face of the harbour and the limits of the survey, and that so far as that portion is concerned, the depths in 1879 are substantially those of 1876.

"14. The next complete survey was made in 1886, and that shows a slight shoaling in about 7 fathoms near the S.E. corner of the harbour. The circumstances attending this will be better described under my second heading, the movement of sand under the influence of surf. For the present, I submit the conclusion that the formation of the harbour as a simple projection into deep water and apart from its influence on surf-driven sand has no appreciable influence on the depths in the neighbourhood of its sea face.

"15. This conclusion is further supported by the facts that during the advance of the piers seaward there was no evidence of scour of the sandy bottom at their ends, and no material acceleration of the alongshore current in either direction. The only occasion on which scour of the bottom occurred was during the heavy sea of November 1881, when a portion of the entrance was deepened about 3 feet and the sand was washed out from the toes of the rubble slopes at the curved portions of the piers. Along the outer face of the piers parallel with the shore there was no deepening on that or any other occasion."

2937. (*Admiral Sir George Nares.*) When you say that there was no acceleration of the current at the pier end; was that by observation or by actual measurement?—It could not be by actual measurement, because there were no previous measurements to compare with; but, as a matter of fact, there was never any material current. Occasionally, the divers might be a little troubled with it; but, as a matter of fact, there was nothing to speak of in the way of current.

2938. Then if there is a current now it must be due to acceleration?—No. What I say here is that as the piers were advancing there was no material current across the line of the piers. As we get out into deeper water we get into the proper locus of the current, and that current never disturbed us, because we were working along in the direction of the current or against it; it was not across the current.

2939. But we are told now that we ought to change the entrance from the eastward, because the current across that entrance is two knots an hour?—We are now going into the question of Mr. Horne's evidence.

2940. It is not only Mr. Horne, but it is a question of a current of two miles an hour affecting a ship entering the easterly entrance?—Two miles an hour I should imagine, from the general knowledge that I have, would be considered a strong current.

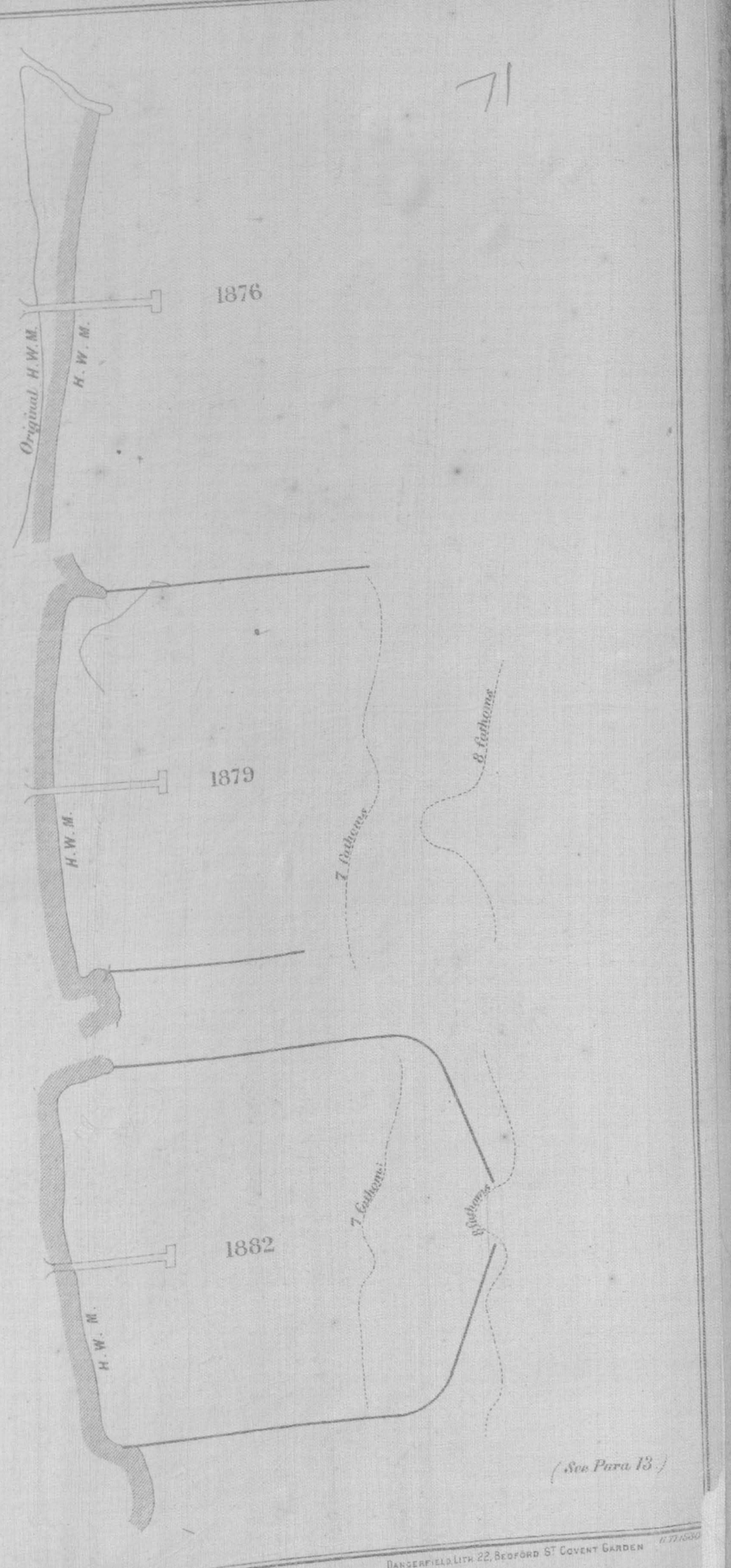
2941. If there is such a current it must be accelerated by the harbour works?—I do not think that it was much accelerated. As I say, we had no very definite observations before the harbour works were constructed to compare it with, and nobody knows under what circumstances this current is produced; so that we could have no means of comparison. But there was a current always spoken of, of a mile and a half, or something of that sort, an hour originally, and there is something like it now; there is no material acceleration of it.

2942. Have there been any current observations for the strength of the current at the end of the pier, and say a quarter of a mile out to compare with it?—No.

2943. Therefore any observations that you are making now about this acceleration are not based upon actual measurements?—Not based upon actual measurements, merely on the experience of the divers and the boatmen about there who are employed on the works. Never, except in rough weather, was there the least effect of the current upon our operations.

2944. (*Sir John Coode.*) Are you prepared to dispute the pilot's statement, that there is occasionally a current of 3 knots an hour?—No, I have always been given to understand that 3 knots an hour is the maximum which various people have testified to. I have never seen it myself.

2945. I asked the question because he stated that he had measured a current of 3 knots?—He said he had measured three. Others have estimated five. But that is only occasionally, and it would be generally in weather in which our men would not be at work.



2946. (*Admiral Sir George Nares.*) We are dealing now not with the works but with actual facts?—I cannot help you more than that; but I never heard of there being a current that would have affected us in any way, or that affected ships in any way:

"16. I now pass to the subject of the movement of sand within the limits of surf action.

"17. Previous to the commencement of the harbour works it was well known that there was considerable movement within these limits. It was known that in the south-west monsoon the movement was from south to north, and in the north-east monsoon from north to south, and this knowledge had been utilized by the construction of a number of stone groynes projected from the shore at intervals whereby the foreshore was extended seaward where required, but it was not known whether the northerly or the southerly movement preponderated, or into what depth of water it extended. These questions were only answered by the record of the effects of the advancing piers."

2947. Did not the groynes show which was the largest movement?—No, not that time. Probably, if I were there now and were watching the effect of the groynes, I might be able to find out something; but at that time I could get nothing to show whether it was greater in one direction than the other.

2948. (*Sir John Coode.*) I understood you to say just now that the groynes to the north of the harbour did show a greater growth on the southern side than on the northern side?—That was after we became acquainted with it. The only other fact that I have to mention here is, that so far as I could find out in 1878, it was not known whether the preponderating movement was from the north or from the south. The groynes at that time were in a state which I could not judge of. At the time I was there the north-east monsoon was on, and the accumulation was from the north.

2949. (*Chairman.*) Then are we to understand that there is no excoriation on either side of the groynes at any time?—There is an annual excoriation on both sides.

2950. That is to say, on the north side during the south-west monsoon, and on the south side during the north-east monsoon?—Yes, in the regular way; but there was not evidence at that time to enable one to decide whether the preponderance of accumulation was on the one side or the other.

2951. (*Admiral Sir George Nares.*) You mean that there was no evidence brought to your knowledge?—Yes, no evidence was brought to my knowledge. Other people may have known of it, but I did not meet with anybody who did; and considering the very various opinions that I heard I do not think that there was any decided opinion about it one way or the other.

2952. (*Sir John Coode.*) Did you examine the existing groynes up and down the coast?—Yes, but I only saw them during one season, and there was nothing upon the face of the groynes to show which was the preponderating action.

2953. There was no definite information available to you notwithstanding your inquiry?—There was a good deal of information with regard to the cost of the groynes, and the date at which they were made, and the effect of them, and so on; but this particular question of whether the greatest movement was from the south or from the north was one which I never succeeded in getting an answer upon.

2954. (*Admiral Sir George Nares.*) Were not there large groynes off Fort St. George?—Yes.

2955. Did not they show any signs that might guide you?—They showed that they produced accumulations of sand around them.

2956. (*Sir John Coode.*) Equally on both sides?—At the time I was there it was smaller on the south than on the north side, because it was during the north-east monsoon.

2957. (*Admiral Sir George Nares.*) Do not the mud rivers on the coast show the travel of the beach?—There is no river, except the Coom, and at that time it was closed up; it was completely beached up.

2958. Or any rivers to the north?—I did not visit them, but I may say this, that so far as indirect evidence goes in questioning people about it I could not get any good evidence of it. Then I go on to say:—

"18. The 'surf bank' of rubble stone which forms the root of the north pier was commenced in January 1876, and by September of that year it had advanced about 700 feet from the original line of high water. The high water line followed it closely on the south side, so that a triangle of new land was formed having a base of 600 feet along the pier, and a length of some 3,600 feet along the shore. The outer end of the surf bank was about on the original line of the 2-fathom contour.

"19. In October, when the north-east monsoon set in, this triangular accumulation began to diminish, and by the following March about one-half of the area of it had disappeared."

2959. (*Sir John Coode.*) You had no means of showing whether it had gone altogether, or whether it had simply been clawed down to a flatter slope?—It disappeared from above the water, and it seemed to get a flatter slope by the time it had travelled away southwards undoubtedly.

2960. (*Admiral Sir George Nares.*) North of the pier, did the first long groyne on the Madras coast extend any beach accumulation?—Yes.

2961. That was the first groyne that would show the actual movement?—Yes; it passed the one groyne, and then it was caught by the next. That is the usual way of all accumulating land; but I may just perhaps mention in passing, that I estimated roughly that it would be about the same cost per annum as the single groyne which I laid down as the basis of my calculations. Then I say:—

"20. Early in 1877, the South Pier Surf Bank was commenced, and by the time the south to north movement commenced, it was sufficiently advanced to form a similar triangular accumulation on its south side. The accumulation continued from March to June, and that not only on the south side, but a portion of the sand passed round the end of the bank and widened the foreshore between the piers by an average of about 80 feet. Between June and September, the bank was further advanced, and the accumulation on the south side extended a further 150 feet, but there was no further advance between the piers, showing that, by the end of June, the bank was in a depth of water in which there was no alongshore movement. That depth was about six feet, which may therefore be taken as approximately the depth within which alongshore movement takes place." That is rather an important point, I think. It is the fact that no sand ever passed it.

2962. No sand that showed itself on the foreshore?—I think I may say more than that. No sand that showed itself by soundings, with the exceptions which I shall be coming to presently:—

"21. The other question as to the preponderance of northerly or southerly movement is answered by the records of 10 years of the positions of the high-water line south of the harbour, which show a fairly regular advance in a diminishing ratio, proving that the northerly movement is not only preponderating, but that the quantity of sand in movement year by year approaches uniformity."

"22. But now a new question was about to arise. In April 1877, when the north pier had advanced to a point at which there was originally a depth of about 3 fathoms, and where the rubble base had been deposited and its surface prepared by the divers at a depth of 15 feet, it was found, after a few days of rough weather, to be buried in 5 feet of sand, and this sand remained immoveable by any means at our disposal for nine months. The accumulation did not extend from the shore, for the waves broke on it and left an interval of green water between it and the surf of the beach. On one or two occasions it cleared away temporarily, and on one of these certainly, and perhaps on others, there was a current running across the line of pier. Generally the water was still. The work made scarcely any progress for nine months, but in January 1878 the sand unexpectedly disappeared, the work was pushed forward rapidly, and by the 1st April, the anniversary of the first appearance of the obstruction, the 4-fathom contour had been nearly reached, and sand has never since been seen on the rubble base. I may add that over a considerable area, where in October 1877 the summit of this accumulation was found with a depth of 9 feet, there is now a clear depth of 16 feet."

2963. (*Sir John Coode.*) You say that the sand never appeared since that date on the surface of the rubble base?—No, not up to this day.

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2964. How long was the rubble base exposed before the blocks were put on it; how long did you leave it to settle?—Sometimes weeks, and sometimes months; it varied considerably.

2965. As a rule, what would it be?—I can hardly tell; perhaps three or four months on an average, but it varied very much according to the rate of the work. It might be occasionally a matter of weeks, but there was no rule about it; when they pressed forward the deposit of the rubble base it got a good way ahead.

2966. Was the surface of the rubble base exposed for any length of time after it was raised to its proper height?—As I tell you, there was no rule about it. Sometimes the building gained, and sometimes the rubble face gained.

2967. Was the period anything like six or nine or 12 months, would you say?—I do not think that it was so much as that. It would be rather an exception if it was.

2968. (*Admiral Sir George Nares.*) Such a mound in 4 or 5 fathoms of water would produce an accelerated current over the top of it, would it not, which might sweep it clear of sand?—No, there was nothing of the sort.

2969. Or at all events it would prevent any deposit?—No, there was nothing of the sort.

"23. An obstruction of the same character occurred in the case of the south pier in 1873 at the corresponding period, and in about the same depth of water. In this case, however, the superintendent was able to obtain a more complete survey of the extent of the accumulation which is shown on the accompanying plan."

2970. (*Sir John Coode.*) What was the depth?—It was about 2½ fathoms; it was going outwards.

"Here it was joined to the surf of the coast line as the latter was advancing rapidly on the south side, but on the north side it appears as a detached shoal with a minimum depth of 6 feet over it. The work was carried on through the sand rather more rapidly than at the north pier by dipping it out in front of the blocks by means of a Bull's dredger. This continued for nine months, and then the clear rubble was again found, and the sand has never re-appeared.

"24. The shoal had been flattened down by the following year, and now there is a depth of 15 feet, where the summit with 6 feet over it existed in 1878.

"25. Within the last 12 months a new feature has presented itself. In every year from 1877 to 1886, the shore line south of the harbour had shown an advance, but no advance had been shown in the contours near and beyond the head of the south pier, which stands in a depth of 7½ fathoms. For the first time, however, the coast line of March 1887 failed to show an advance beyond that of the previous year, but, on the contrary, showed a retreat nearly equal to the advance from 1885 to 1886, while, also, for the first time, the 7½ and 8 fathom contours showed an advance representing a decrease of depth of about 2 feet. A similar shoaling is apparent inside the harbour on the 7 and 7½ fathom contours, but it does not extend to that of 6 fathoms.

"26. For the first time also since the commencement of the harbour works there was a heavy cyclone sea in *May*. All previous heavy seas had been in *November*.

"27. There are certainly some circumstances which would tend to make the results of a May storm differ from those of a November storm, if the wind in both come from the same quarter. In November the current produced by a northerly wind would accelerate the normal N.E. monsoon current, while in May the storm current would neutralize the normal S.W. monsoon current. In the former case the sand raised by the surf and carried out to sea in suspension would drift away to the southward out of the limits of observation; in the latter case it would be conveyed into still water and there deposited.

"28. I cannot, however, assign any reason why a May storm should cause a retreat instead of an advance of the shore line, and in some other respects disturb the regularity of the advance which had been apparent for 10 years previously, but I cannot attach any practical importance to these irregularities.

"29. The quantity of sand which had accumulated in those 10 years was between ¼th and ⅓th of that which would be required to advance the 4-fathom contour to the line of the sea face of the harbour, and till it has advanced to that extent it cannot be considered as threatening injury to the entrance. As the irregularities of the last year do not show any increase in the quantity of sand, but only in the form of its distribution they need not, I think, suggest any material modification of the conclusion that no serious injury need be anticipated for many years to come. In the meantime, the accumulation is forming a site of very great value to the trade of the port.

"30. The accumulation to the south of the harbour is, as might be anticipated, accompanied by a corresponding erosion to the north. For some distance to the north the property is valuable, and is protected from erosion by suitable works, mainly a rough stone revetment along the line of shore extending to a point 2,450 feet from the line of the north pier. Up to this point, it remained complete though requiring occasional strengthening for two or three years previous to 1882, the land beyond being allowed to disappear before the action of the waves, the owners being duly compensated.

"31. In that year, however, the Government determined to buy up all the land shaded on the accompanying plan, and to extend the revetment along the then line of shore for a further 1,900 feet. The plan shows the general encroachment of the sea since that time, the lines of high-water mark being taken in September when the encroachment is at its maximum. The line of 1886 shows a greater advance than those of previous years, which may be attributed to the storm of the previous May.

"32. It is anticipated that by a continuance of these records for a few years longer, some inexpensive mode of directing the encroaching force on the less valuable property to the northward may be suggested. For the present, the most economical course appears to be to let the land be washed away. Its value is less than the cost of protecting it by stone revetment, and small compared with the prospective value of that gained to the south of the harbour.

"33. I would summarize the conclusions herein submitted, as follows:—

"1st. The sandy bottom in depths exceeding one fathom is subject to alongshore travel from south to north in the south-west monsoon, and from north to south in the north-east monsoon, the quantity travelling being greater in the former season than in the latter. As a consequence of this, land accumulates to the south of the harbour and wastes to the north.

"2nd. In a depth of about 2½ fathoms there is a tendency for the sand to accumulate in the neighbourhood of the abrupt termination of a solid obstacle such as a vertical pier. This accumulation is quite distinct from the alongshore movement within the depth of one fathom, and disappears when the abruptly terminating obstacle is converted into a continuous wall."

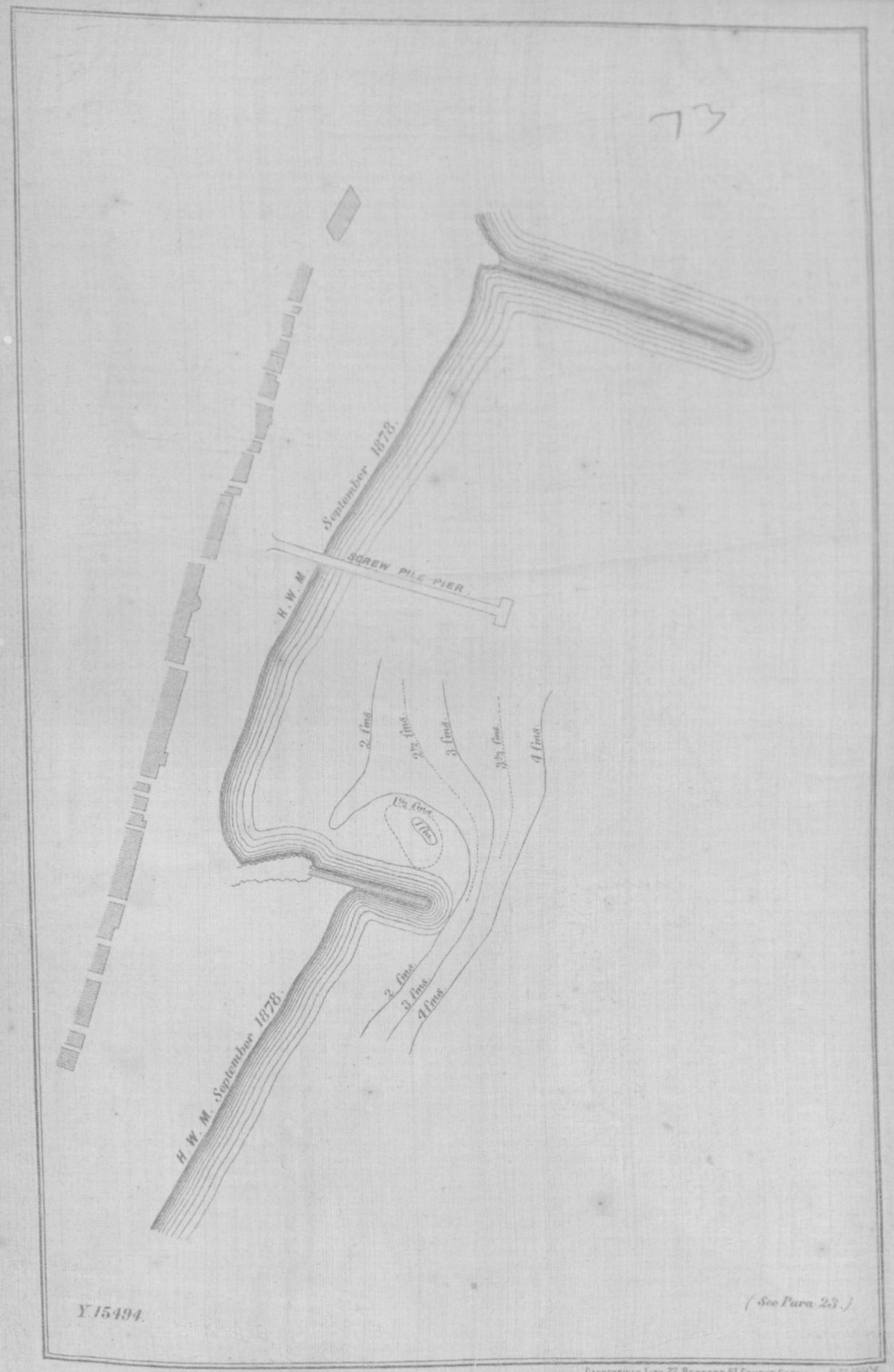
2971. (*Chairman.*) There is another thing that you had before you when you were forming your plans for the construction of the harbour, and that was having a De Havilands bulwark?—That was there, but I do not know that it affected my plans in any way.

2972. Did it not give you some data to go upon?—No, I found little or no information about it. I have got more information about it since than I got at that time. At that time the top of it was occasionally visible above the water. It is well inshore now, and there is a good width of beach outside it. At the time that it was built these buildings, which you observe on the plan, were threatened by the sea, and this bulwark was built to protect them. Then, after that, groynes were projected outside, and those groynes accumulated the beach and buried the bulwark.

2973. (*Sir John Coode.*) It was a sort of breakwork, in fact, along the sea front, was it not?—Yes.

2974. (*Chairman.*) There was also a breakwater, Sir Arthur Cotton's breakwater, further out, was there not, near about where the end of the pile pier is now?—Not very far from there. We found some of the stones in sounding, and only in sounding. We discovered some few scattered stones, but very little; it was a very small affair, and it was dissipated in a very short time.

2975. (*Sir John Coode.*) What was the nature of its construction?—Just rubble stones tumbled in.



/A.

MADRAS HARBOUR WORKS.

Plan shewing Loss of Land North of Harbour.

The land shaded has been purchased by Government.



Y. 15494.

2976. Were there any of any large size?—No, I fancy not.

2977. Is there no record of it?—I could not get any useful record of it at all. Sir Arthur Cotton himself told me more about it than I could find anywhere else, but that was very little.

2978. (*Chairman.*) Do you think that it was dissipated by the beating of the surf, or by sinking?—I think it is very likely that it sank a good deal; no doubt it was dissipated by the action of the surf to begin with, but then the sand accumulated round it, and I daresay it sank into the sand. It will sink into the sand near the shore; further out there is not so much sinkage. I see with regard to some remarks of Captain Taylor's as to the sinking into the sand, that on a comparison of the whole quantity of rubble stone deposited in the whole work, it was found that there was no sinking into the sand at all.

2979. (*Admiral Sir George Nares.*) Whereabouts was that?—Taking the whole length of the work, and the piers, there was no loss which we could attribute to the stone rubble sinking into the ground.

2980. (*Sir John Coode.*) In fact, there was no subsidence of the rubble base into the bottom of the sea bed?—None whatever.

2981. (*Admiral Sir George Nares.*) But at certain part the sand is of a quicksand nature, is it not?—I never saw quicksand there.

2982. Would the accumulated sand south of the pier after a cyclone be for some days of a quicksand nature?—I do not think so, but I cannot speak of my own knowledge upon that point. I have never heard of its being in any way of a quicksand nature. It is composed of coarse particles of sand of the size of peas, or even larger, and sometimes it is finer; it is very variable, but it is a good solid sand, and fit to build anything upon requiring no concrete bottom or anything of that sort.

2983. (*Sir John Coode.*) But that fine character of sand along the foreshore which you have been describing, I understand is similar to the sand in deep water?—No; this which I have been speaking of is fine solid sand, and persons can walk upon it without sinking into it at all. There are occasional deposits, perhaps, of débris from the sewers, such as road sweepings and fine stuff, which forms mud which lies for a time in the bottom, and gets ultimately swept away by the action of the waves. I do not think that the currents touch it.

2984. (*Chairman.*) Do you say that the Madras sand is generally of the size of a pea?—I do not say that it is so generally, but I have seen it of that size; it varies from that to fine sand.

2985. (*Sir John Coode.*) What proportion of the whole mass would that be?—It varies extremely. Sometimes there will be a heap of it at one place of that size, and it is used for concrete. At other times there may be a difficulty in getting this coarse sand.

2986. Then the presence of coarse sand is exceptional?—Yes, I should say it is rather exceptional than otherwise, but it is to be found there. I do not think that there is anything, so far as I know, along the beach at all in the shape of quicksand. Whenever I have walked upon it, it has been perfectly solid where it is under the wash of the waves.

2987. Have you the details of Mr. Thorowgood's estimate for design, No. 3?—No, I have no details whatever; in fact, I know nothing at all about it, except what I have heard from the Committee.

2988. Your knowledge would enable you to test it, would it not?—I could make an independent estimate, but it would be entirely independent. I could tell you what the work would cost per foot. I have made a copy of a contemporary account of the loss of those two steam hoppers in 1881. I thought it was desirable to do it after reading Colonel Sankey's evidence upon the subject. He was not present at the time, and he seemed to me rather to imply that they were lost from the great force of the sea; but that was not the case. The reason of their loss was as clear as possible.

2989. (*Chairman.*) We have had evidence from many witnesses that all the harbour craft were destroyed by the sea inside the harbour before the walls went away?—That might be the case with the Masoolah boats and the cargo boats, but those were two steam hopper barges that were lashed together; they had been previously employed in putting down moorings, and they were lashed together with beams laid across and a well between them. The casualty happened out in about 5 fathoms about 300 yards from the north pier in the north-west angle. I think it is rather an important matter to notice the way in which they behaved. Mr. Thorowgood wrote to me privately on the 15th of November 1881 to this effect: "The steamers rode out "the storm most admirably, those on board being quite "comfortable until the stern moorings parted, then the "vessels swung and hammered one another a great "deal. They suddenly went down, and nothing could "be done to save the crew. Nothing would prevail on "the boatmen to face the surf as it was then in the "harbour." After the breakwater had given way those vessels were riding quite comfortably, and they had no idea of danger until the wind came round a little to the northward and then carried away their stern moorings and exposed them broadside to the sea; then they were in a very unfavourable state for riding out a sea, because the two hoppers were lashed together with temporary timber work. There is another account of it, but this is from Mr. Thorowgood's report to the Government. I saw one of the people myself, and he is now foreman on the harbour works. The captain and several of the crew were drowned; but this foreman, who was on board, was saved, and several Lascars were saved; three or four of them clung to the rigging, which was standing out of the water, and they clung to it for several hours; but this foreman was on board, and I have talked with him about it frequently, and he said that he had not the slightest idea of any danger, and that they were perfectly comfortable there so long as the stern moorings held. He himself was thrown into the water, but he fortunately had a lifebuoy. He was three or four hours in the water, and insensible, and he was landed on the southern part of the harbour on the beach. A great point has been made of the great outsetting current during that storm. This man who lived to tell the tale actually crossed over the line of entrance and was not carried out to sea, and I maintain that if those vessels had been properly moored they would have ridden out the cyclone.

2990. (*Sir John Coode.*) It is pretty evident that there was a current, because it was discoloured to a considerable extent?—There was a current, I do not deny that; but it was not felt much inside the harbour; it was all concentrated in one particular part close to the entrance and scoured it out.

2991. (*Admiral Sir George Nares.*) The *debris* was carried out, was it not?—I do not think there was much *débris*; there was some wreckage carried out. Mr. Thorowgood always maintained that until that storm the waves that came over the breakwaters did not cause any disturbance inside the harbour. On that occasion they did, but the less furious seas just fell over, and created no disturbance.

2992. (*Sir John Coode.*) Is there any other point in Captain Taylor's or the pilot's evidence which you would like to remark upon?—I have met most of the points in Captain Taylor's evidence, but there is one point in General Sankey's evidence, if I might be allowed just to mention it; he speaks of Stevenson's formula for the reduction of waves, and he seems to imply that Kingstown Harbour is more favourably shaped for reducing the waves than Madras, because it has a greater length. I do not quite know what he means by the length; but, however, the length as measured, I think, to the end of Madras Harbour is greater than that of Kingstown, certainly in comparison with the width of the entrance. What I should call the width of Kingstown is 3,500 feet, and that is measured across parallel to the shore, with a 700 feet opening. That compared with a 700 feet opening is less than the 3,000 feet at Madras compared with a 550 feet opening: but I think that Madras, as it is shaped, is as suitable a case for the application of Stevenson's formula as there could be, and I cannot see anything in the formula to cause it to fail at Madras. With regard to General Sankey's theory about the wave translation, I think that really ought not to pass without some contradiction. It is one that I do not think will hold water at all. His idea seems to be that the wave enters the harbour with a velocity nearly equal at all depths, uniform from the surface to the bottom, and that velocity is something very great. According to the usual idea of wave translation it would be the velocity with which the wave is travelling. It certainly is nothing like that. The lateral force is not uniform at Madras from the surface to the bottom, but it decreases

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was not sufficient, you could introduce, at least, one more jetty on each side?—Undoubtedly you might.

3027. Surely, if the principle is good for one small jetty, it is good for more jetties to the extent to which you have sufficient space to insert them?—I do not think that this jetty would ever be built inside the new harbour, as it is now. It was built when the harbour was all open sea. It was a very expensive affair, built with 8-inch wrought-iron piles.

3028. Still, might it not be better to construct a basin of this size with modifications?—It might be done, no doubt, but that jetty, as it now stands, has facilities that can be developed to an enormous extent. The new jetties would not provide shelter for boats; shelter for boats may be provided upon the reclaimed land to the south of the harbour at comparatively small cost.

3029. It is not shelter only that is required; it is the means of carrying on trade; and if you make this basin to the south, it must not only be a shelter basin, but a basin along the sides of which you can carry on a large trade?—That is not so absolutely essential, because, as I say, for 350 days of the year the beach between the two piers is good enough for beach work, and the screw-pile pier can be enormously improved; but I quite agree that if the use of the screw-pile pier turns out to be so convenient that it could be repeated with advantage, that could easily be done. But shelter here is absolutely necessary, and small jetties could be erected at very small cost on the land side of the boat harbour.

The witness withdrew.

CAPTAIN H. TAYLOR further examined.

Capt. H. Taylor.

3030. (*Chairman.*) Can you tell us what becomes of the sand from the north side of the harbour—in which direction it goes away?—There is very little now.

3031. In which direction did it go?—It swept along the coast before the obstruction of the harbour intervened.

3032. But excoriation did not take place until after the harbour was built?—Exactly so.

3033. Which way did it go then?—It was arrested by the harbour, and now forms that bank on the south side.

3034. I am speaking of the north side?—Very little remained at the north, but what there was dribbled along the coast, and part of it came back though not enough to fill up that little bay in the arm of the harbour at the back of the north pier.

3035. You have hardly answered my question yet. There was a sandy beach, was there not, on the north side of the harbour precisely similar to that on the south side inside the harbour?—There was a sandy beach to the north originally.

3036. And that sand is now gone?—Yes, that sand is now gone.

3037. And would still go if you did not stop it by means of a revetment?—Exactly.

3038. Which way did it go, and would it go—would it go to the northward or would it come out along the line of the face of the harbour?—Removing the obstruction caused by the harbour altogether, the sand used to dribble along the coast, and a proportion of it came back in the north-east monsoon, but by far the greater proportion came up from the south in the south-west monsoon; when this obstruction was made clean water came round and excoriated this part.

3039. You say that the water coming from the south has excoriated the sand from the north side?—Yes, it cuts it right away; you can see it go.

3040. We have had two opinions upon the subject; one was that it was taken away by the current from the northward right along the north face, and some of it deposited on the south side, and the other opinion is just what you have said, that it was carried away to the northward?—I do not suppose anybody's opinion can equal the years of observation that we have had there. I do not know anybody who could give an opinion. We have spent a large amount in revetting this portion a mile and a half north of the harbour to save the houses. Colman's large house, which used to be safe, on the beach was endangered, and all the outworks have been washed away.

3041. We do not question the fact that the sand has gone, and will still go if you allow it; but what we wish to know is which way it goes. The strongest current is from the north, is it not?—No, only for a few days in stormy weather, and sometimes even then it comes from the south, it depends upon where the centre of the storm is.

3042. Putting storms out of the question, what would you say?—Putting storms out of the question, there is no quieter or simpler place in the world than Madras, and no easier port and no one where ships would have less trouble. There is no question in my opinion, or in the opinion of anybody in Madras, about any nautical considerations whatever. The harbour being made, we consider that that closed-in sea face would give us full space that we can utilise and make the place really useful.

3043. But the question now is which way the sand went—what does become of the great quantity of sand which, according to the statement of all the parties who have been before us, and which is admitted on all hands, has been removed from the foreshore north of the harbour?—There is very little indeed. The revetment comes up to what they call the upper houses of the town.

3044. When you yourself say that it has been scoured back to a considerable extent, what has become of all the sand?—If there is any, it goes along the coast, past the revetment there is a big bay forming, and a fishing village has been cut away as well as two streets.

3045. (*Sir John Coode.*) What becomes of the sand?—It goes north, and the clean water comes round and carries it away. The fact is, if you look at it from a Madras point of view, you will see that the surf beating on the sand, the waves of the sea become loaded with sand and that is carried along by the prevailing current, —the prevailing current being from the south,—and the clean water coming round excoriates the beach just as it does on all this coast. For two months of the year the current runs longer from the south than it does from the north.

3046. Taking the whole year round, what is the predominating current?—From south to north.

3047-8. (*Chairman.*) But it is a very much weaker current, is it not, than from the north?—Not at all, except in the case of a cyclone, and then during that time the body of the storm pressing on the land sometimes squeezes the water north and sometimes south.

3049. Perhaps I can make clear to you the object of this question. Plan 3 is the plan that you propose on behalf of the Madras Trust; there is no doubt about the excoriation here (*pointing to the plan*)?—No doubt about it.

3050. That is caused by the current coming from the north, is it not?—No, it is caused by the current whisking round the harbour from the south.

3051. As we understand you, the sand that is removed from the coast to the north of the harbour is removed by the current coming up from the south and carried away to the north, and therefore, there is no danger of that sand being carried in an opposite direction and filling up the proposed mouth of the north-east corner?—No danger whatever. We are considering a matter which takes place under our eyes, we all see that the excoriation goes on to the north, and we are secure of deep water here (*pointing to the plan*); we can never get it from any other quarter, and what is more, the harbour can never be improved from any other. The water on the north side of the harbour continues to deepen, but on the other side it is a steady increase of sand.

3052. (*Sir John Coode.*) Then I understand you that the water on the north side, that is, at the back of the north pier, is deepening?—Yes.

3053. And that that deepening is owing to the existence of a predominating current from the south passing along the sea face of the harbour and striking along the back of the north pier, and then up the shore, and so scouring out a bed at the back of the root of the north pier?—It has ceased to do that now.

3054. That has been the action?—That was the action until the jetty was washed away. We used to land locomotives there formerly.

3055. Are you very clear upon that point; have you seen such a current as that?—Yes.

3056. Have you seen it passing round the face or the front of the work, and then along the back of the north pier?—You do not see the water in motion, but you see the effect. There is no absolutely clear water there.

3057. If you do not see it, it must be an assumption?—But you miss the sand, you miss the jetty, and you miss the wall and the houses.

3058. (*Chairman.*) That is no reason for saying so, that is not carried away by the north current?—But where would the stones come to? They are either in this little bay which I am speaking of, or they are further away to the north.

3059. (*Sir John Coode.*) The pilot has said that the sand has been scoured away by the current from the north striking the back of the north pier?—He knows nothing about it. We had to pay a great deal of compensation the other day for the road being washed away by the current.

3060. Do you think that your diver could tell if there is anything of the kind there?—No, his operations are purely inside the harbour.

3061. He has been working along that end of the work, and, of course, if there were a current either way, he must naturally have felt it?—I do not think that the pilot really has said that this was washed away by the current from the north; but if he did he really is no judge of it. He has quite enough to do from six in the morning till six in the evening bringing ships in and out.

3062. (*Admiral Sir George Nares.*) Does the northerly monsoon disturb the sand on the beach off Madras?—The beach off Madras is now divided into two, one half of which it is necessary to revet in order to keep it in its position, and the other half of which is accumulated up with a mass of sand.

3063. On the coast two miles north of Madras, does the northerly monsoon breaking on the beach disturb the sand?—There is very little sand on the north line. The Casuarina plantations come down to the water's edge, and even up to Ennore, which is 9 miles from Madras, there is a movement backwards and forwards by the current. It goes up to a certain point, and then goes back again.

3064. The sand immediately north of the revetment is not forced along there by the north monsoon, is it?—Immediately north of the revetment there is a little bay forming, which, as I say, has already taken away one row of houses, and is now inspinging upon the next road, and that is caused by the action from the south.

3065. Is the sand in that bay carried northward by the southerly monsoon and brought back again by the northerly monsoon?—It has cleared away up to a wall of about five or six feet high the main body of the land. The beach does not extend there at all. The beach, properly so called, is stopped there. But then the sea cuts in, and forms a wall sometimes four, or five, or six feet high, and this, as I say, has cut away one row of houses completely, and half of a fishing village, and it is also now threatening another road; so much so, that the people in the next street are calling upon us to pay compensation for their land. If there was any sand coming from the north in that quantity it would show itself at the back of the north pier, but it does not.

3066. I want to know whether any sand is brought south to fill up the bay north of the revetment in a northerly monsoon?—Very little indeed; so much so that one can hardly tell one monsoon from the other. It is protected now by the revetment. There is only a small corner where there is a sand bay, and that, as I say, is let to the railway company, where they land their coals and their railway stores,—at least, excepting in last November, when the storm came and a great deal of the revetment was carried away, and we had a great many claims sent in to us for compensation for the land. The Sailors' Home, for instance, and all kind of work was washed away by it from the current coming in from the north.

3067. Then the current coming in from the north, you say, brings a little sand; does it discolour the water?—I have never seen it. Not more so than water always is discoloured on a beach.

3068. As far out as the breakers?—I need hardly say that when the surf is breaking on the beach there is always some discoloration of the water close in to any part of the world.

3069. Does it end south of the revetment, or does it extend the whole way from the revetment to the north pier, or is the discoloration of the water in the breakers?—I do not see how any answer can be given to the question.

3070. It is a plain question, is it not?—It is a plain question, but it does not seem to me to bear upon the matter. If you have a beach anywhere in the world you will find that the breaking water has sand in it.

3071. Then we may take it that the whole of the water from well north of the north pier is discoloured by the northerly monsoon?—Just the same as any beach is, but less so than it would be on account of the stone revetment. There is no sand to take up.

3072. Do you find any quantity of sand at the end of a north monsoon at the base of the north pier outside the harbour in the corner?—There is a little; the north-east monsoon supplies a little sand there.

3073. Then there is a little sand brought south?—Yes, brought south from north.

3074. Up to the north pier by the north monsoon?—Yes, the return current brings a little mud along with it.

3075. (*Sir John Coode.*) What becomes of it?—The next monsoon carries it away. You cannot go any further than that.

3076. (*Admiral Sir George Nares.*) Can we trace the discoloured water along the north face of the north pier with a northerly monsoon, or is it perfectly blue water?—No; no water is blue so near the land as that in bad weather. Of course, it is always more or less charged with discoloured matter all along; not at the north pier alone, but all the way along the whole coast.

3077. In a northerly monsoon, does the discoloured water extend out beyond the harbour?—Where the water breaks in nine or ten fathoms there is always a certain amount of discoloration. It is the same in every part of the world. I know of no difference in any other part of the world to this matter, excepting as the sand in motion is obstructed by the harbour wall.

3078. Then we may take it, may we not, that, owing to the northerly monsoon, the water is discoloured from the shore out to the end of the north pier?—No. I do not say that at all, it depends upon the weather. In very rough days it would be found out as far as the north pier probably; but close in where it is five-fathom water, and off that shore I have never seen perfectly blue water close in there.

3079. Can you tell us anything about the discharges of the drain after heavy rains outside the harbour on the north side; we are told that the drain carries down very dirty water?—Yes, it does.

3080. Can that be traced by the discolouration of the sea round the north pier?—That would demand a great deal upon the time of the day to which the drain is opened. I think the inhabitants work mostly all day at their occupations, and go home at night, and the sewer is generally opened at night, so that sewer and opportunity of judging about it. Both that sewer and the one from the fort are generally opened at night, so as to give as little inconvenience as possible to the inhabitants.

3081. Is there a great deal of surface drainage that comes to the north pier?—No, and surface drainage is only storm-water. It does not go out to the north because the opening at the south entrance is a very small one. The storm-water is supposed to go along an intercepting drain, and to come out into the harbour wherever there is an opening.

3082. But the final opening is outside the harbour on the north side, is it not?—That is the sewage opening.

3083. Not the storm-water opening?—You must put the municipal officers to answer that question.

3084. Have you observed any difference on the north side of Madras Harbour in the discoloration of the sea after heavy rains, or an ordinary rain with a northerly monsoon?—I have never noticed it. Wherever the drain is opened there is a horrible smell which has

2976. Were there any of any large size?—No, I fancy not.

2977. Is there no record of it?—I could not get any useful record of it at all. Sir Arthur Cotton himself told me more about it than I could find anywhere else, but that was very little.

2978. (*Chairman.*) Do you think that it was dissipated by the beating of the surf, or by sinking?—I think it is very likely that it sank a good deal; no doubt it was dissipated by the action of the surf to begin with, but then the sand accumulated round it, and I daresay it sank into the sand. It will sink into the sand near the shore; further out there is not so much sinkage. I see with regard to some remarks of Captain Taylor's as to the sinking into the sand, that on a comparison of the whole quantity of rubble stone deposited in the whole work, it was found that there was no sinking into the sand at all.

2979. (*Admiral Sir George Nares.*) Whereabouts was that?—Taking the whole length of the work, and the piers, there was no loss which we could attribute to the stone rubble sinking into the ground.

2980. (*Sir John Coode.*) In fact, there was no subsidence of the rubble base into the bottom of the sea bed?—None whatever.

2981. (*Admiral Sir George Nares.*) But at certain part the sand is of a quicksand nature, is it not?—I never saw quicksand there.

2982. Would the accumulated sand south of the pier after a cyclone be for some days of a quicksand nature?—I do not think so, but I cannot speak of my own knowledge upon that point. I have never heard of its being in any way of a quicksand nature. It is composed of coarse particles of sand of the size of peas, or even larger, and sometimes it is finer; it is very variable, but it is a good solid sand, and fit to build anything upon requiring no concrete bottom or anything of that sort.

2983. (*Sir John Coode.*) But that fine character of sand along the foreshore which you have been describing, I understand is similar to the sand in deep water?—No; this which I have been speaking of is fine solid sand, and persons can walk upon it without sinking into it at all. There are occasional deposits, perhaps, of débris from the sewers, such as road sweepings and fine stuff, which forms mud which lies for a time in the bottom, and gets ultimately swept away by the action of the waves. I do not think that the currents touch it.

2984. (*Chairman.*) Do you say that the Madras sand is generally of the size of a pea?—I do not say that it is so generally, but I have seen it of that size; it varies from that to fine sand.

2985. (*Sir John Coode.*) What proportion of the whole mass would that be?—It varies extremely. Sometimes there will be a heap of it at one place of that size, and it is used for concrete. At other times there may be a difficulty in getting this coarse sand.

2986. Then the presence of coarse sand is exceptional?—Yes, I should say it is rather exceptional than otherwise, but it is to be found there. I do not think that there is anything, so far as I know, along the beach at all in the shape of quicksand. Whenever I have walked upon it, it has been perfectly solid where it is under the wash of the waves.

2987. Have you the details of Mr. Thorowgood's estimate for design, No. 3?—No, I have no details whatever; in fact, I know nothing at all about it, except what I have heard from the Committee.

2988. Your knowledge would enable you to test it, would it not?—I could make an independent estimate, but it would be entirely independent. I could tell you what the work would cost per foot. I have made a copy of a contemporary account of the loss of those two steam hoppers in 1881. I thought it was desirable to do it after reading Colonel Sankey's evidence upon the subject. He was not present at the time, and he seemed to me rather to imply that they were lost from the great force of the sea; but that was not the case. The reason of their loss was as clear as possible.

2989. (*Chairman.*) We have had evidence from many witnesses that all the harbour craft were destroyed by the sea inside the harbour before the walls went away?—That might be the case with the Masoolah boats and the cargo boats, but those were two steam hopper barges that were lashed together; they had been previously employed in putting down moorings, and they were lashed together with beams laid across and a well between them. The casualty happened out in about 5 fathoms about 300 yards from the north pier in the north-west angle. I think it is rather an important matter to notice the way in which they behaved. Mr. Thorowgood wrote to me privately on the 15th of November 1881 to this effect: "The steamers rode out "the storm most admirably, those on board being quite "comfortable until the stern moorings parted, then the "vessels swung and hammered one another a great "deal. They suddenly went down, and nothing could "be done to save the crew. Nothing would prevail on "the boatmen to face the surf as it was then in the "harbour." After the breakwater had given way those vessels were riding quite comfortably, and they had no idea of danger until the wind came round a little to the northward and then carried away their stern moorings and exposed them broadside to the sea; then they were in a very unfavourable state for riding out a sea, because the two hoppers were lashed together with temporary timber work. There is another account of it, but this is from Mr. Thorowgood's report to the Government. I saw one of the people myself, and he is now foreman on the harbour works. The captain and several of the crew were drowned; but this foreman, who was on board, was saved, and several Lascars were saved; three or four of them clung to the rigging, which was standing out of the water, and they clung to it for several hours; but this foreman was on board, and I have talked with him about it frequently, and he said that he had not the slightest idea of any danger, and that they were perfectly comfortable there so long as the stern moorings held. He himself was thrown into the water, but he fortunately had a lifebuoy. He was three or four hours in the water, and insensible, and he was landed on the southern part of the harbour on the beach. A great point has been made of the great outsetting current during that storm. This man who lived to tell the tale actually crossed over the line of entrance and was not carried out to sea, and I maintain that if those vessels had been properly moored they would have ridden out the cyclone.

2990. (*Sir John Coode.*) It is pretty evident that there was a current, because it was discoloured to a considerable extent?—There was a current, I do not deny that; but it was not felt much inside the harbour; it was all concentrated in one particular part close to the entrance and scoured it out.

2991. (*Admiral Sir George Nares.*) The *débris* was carried out, was it not?—I do not think there was much *débris*; there was some wreckage carried out. Mr. Thorowgood always maintained that until that storm the waves that came over the breakwaters did not cause any disturbance inside the harbour. On that occasion they did, but the less furious seas just fell over, and created no disturbance.

2992. (*Sir John Coode.*) Is there any other point in Captain Taylor's or the pilot's evidence which you would like to remark upon?—I have met most of the points in Captain Taylor's evidence, but there is one point in General Sankey's evidence, if I might be allowed just to mention it; he speaks of Stevenson's formula for the reduction of waves, and he seems to imply that Kingstown Harbour is more favourably shaped for reducing the waves than Madras, because it has a greater length. I do not quite know what he means by the length; but, however, the length as measured, I think, to the end of Madras Harbour is greater than that of Kingstown, certainly in comparison with the width of the entrance. What I should call the width of Kingstown is 3,500 feet, and that is measured across parallel to the shore, with a 700 feet opening. That compared with a 700 feet opening is less than the 3,000 feet at Madras compared with a 550 feet opening; but I think that Madras, as it is shaped, is as suitable a case for the application of Stevenson's formula as there could be, and I cannot see anything in the formula to cause it to fail at Madras. With regard to General Sankey's theory about the wave translation, I think that really ought not to pass without some contradiction. It is one that I do not think will hold water at all. His idea seems to be that the wave enters the harbour with a velocity nearly equal at all depths, uniform from the surface to the bottom, and that velocity is something very great. According to the usual idea of wave translation it would be the velocity with which the wave is travelling. It certainly is nothing like that. The lateral force is not uniform at Madras from the surface to the bottom, but it decreases

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very rapidly indeed, and much more rapidly than a wave of pure oscillation outside; and the proof of that, I think, will be found in this fact. I obtained for Professor Stokes some observations of the periods of waves, and from these he calculated that the lateral force at 8 fathoms deep would, in a wave of pure oscillation, be one-half of the lateral force of the water at the surface. In the waves that actually attacked us, the force at the surface was sufficient to bowl over 27-ton blocks, and the force at the bottom at 8 fathoms was barely sufficient to disturb the sand. Now, it is perfectly clear from that that the wave was changed from its condition of a wave of pure undulation, as it is out at sea in deep water, to the condition of a wave immensely intensified at the surface, and very much reduced at the bottom.

2993. (*Sir John Coode.*) You argue that that force would be greatly reduced in 7 or 8 fathoms?—That is a very different assumption from that of General Sankey. He says that it is uniform; that it comes in at that entrance with a uniform body of water.

2994. (*Chairman.*) Captain Taylor was charged with the opinions of the Madras Harbour Trust, and he put in four plans, of which No. 1 is the plan which is already known to you, and which we have discussed here with you. No. 3 is the plan favoured by the Madras Harbour Trust Board. It is unaccompanied by any specifications, but merely by an estimate of the expense without any particulars. Will you be so good as to take that plan into consideration, and give the Committee your idea as to its advantages over the Plan No. 1, and also a rough estimate as to the cost in the event of its being adopted?—Of course I cannot speak as to its nautical merits or its comparative merits nautically, but I think that Plan No. 3 will turn out to be very much more expensive than No. 1, even with the overhang on No. 1 lengthened to the same extent as No. 3 would.

2995. I omitted to point out to you that in No. 3 the northern arm stops at the point which the work has now reached, and that it will not be necessary to remove any of that superstructure?—I think myself that that is a fallacy. I do not think that the removal of the superstructure adds very enormously to the cost. I think the difficulty of removing the part that is entirely submerged is very considerably increased by there being no approach to it by means of a superstructure. A great deal of the material that lies around that built work could be removed more easily by means of machines placed upon the present work, and that the built work itself could be removed at comparatively small cost; so that I should say that the object of saving that is certainly no sufficient reason for departing from Plan No. 1 if there are no other advantages to be obtained. There is not only the enormous cost of removing all that submerged work in No. 3, but also there is the great length of time it would take. Probably a year or a year-and-a-half would be sufficient to complete the south pier to the present entrance, and you must then stop entirely until the new entrance is made.

2996. I should tell you that it is proposed to commence upon that clearance at once?—That I was anticipating, but supposing that they begin at once the clearing of the submerged work and the building of the south pier, those two operations would go on concurrently as long as the building of the south pier lasts, but when that is finished up to the southern boundary of the present entrance everything will have to stand still until the removal of the submerged work is finished. But the length of time that that will take I think must be considered to be a mere guess. For my own part I should be sorry to express any expectation of its being done under five or six years.

2997. In the meantime, according to the Harbour Trust, the harbour is in no worse position than it is now until that is cleared?—The submerged work being of some use as a shelter, of course it becomes of less and less use as it is being removed. On the other hand, if we go to No. 1, the work would go on continuously until both piers were finished up to the present entrance, and then the titan would be turned round, and would work out to the northward with the overhang. That would have to be finished before the work in the new entrance was commenced. But the work of removal will be carried on under much more favourable circumstances, not only from there being a piece of built work to work from, but also on account of its being under the shelter of the new overhang. In the meantime they will have the benefit of the present entrance of the harbour as it was originally intended to be, which will certainly be very much better, with, say, a 500 feet entrance, than it would be in Plan No. 3 with an entrance of 1,700 feet.

2998. (*Sir John Coode.*) But that portion of 1,700 feet would be within a very small distance of the surface; it does not extend to the full depth at the entrance, does it; this 1,700 feet is only just submerged?—All that adds to the difficulty of its being removed.

2999. It adds to the difficulty of its being removed, but still it gives a certain amount of shelter?—Yes, it gives a certain amount of shelter, but that shelter would be continually diminishing as it is being removed. There would be an opening of 1,700 feet before they could begin to carry on the south pier and to give the new shelter. I think, at least, that those are considerations which certainly would have very great weight with me if I were advising upon the matter, and I do not see in what way when it is finished, No. 3 entrance is better than No. 1, always supposing that this is carried out sufficiently as an overhang; the present design of 300 feet is quite insufficient.

3000. What do you say with regard to the hollow or the re-entering angle at the sea face of the work according to Plan No. 1?—I do not think that is a matter of any great consequence.

3001. Have you ever formed any idea of the cost of putting down sufficient blocks to practically straighten the sea face of the work?—I think that would be a very serious matter.

3002. Though obliterating the whole angle would be a serious matter, have you ever thought that it might be done by reducing the curve, and making it for all practical purposes a straight line, though not absolutely straight?—It is difficult to say what for practical purposes is a straight line. For myself I know many of those hollow curves exposed to the sea, and they stand very well. There is one at Holyhead, and one at Marseilles, I think.

3003. You will remember that at Holyhead they had to put down an enormous berme across the re-entering angle. Then again at the Tyne, you may remember they had a re-entering angle not very different from this to which the engineers, both Mr. Ure and Mr. Messent, attributed the damage to the work, simply because the sea breached through at that angle?—Yes; and there is the same thing in Alderney. At the same time they have been made, and I believe they stand well. Am I to understand that these are the only two plans before the Committee?

3004. There was a No. 2 plan; it is not very different from No. 1, because it retained virtually the sea face of the northern arm?—Yes, I observe it does. I should think that it would be worth consideration whether something between No. 1 and No. 2 might not be desirable. No. 1 seems to me to turn out rather sharply; of course the more it turns out the more the sea comes in. No. 2, perhaps, covers the entrance too much.

3005. But would throw the vessel too much inshore before she could enter?—Yes.

3006. As a matter of cover simply, you cannot cover the entrance too much. Your objection I suppose is, that it would bring a vessel too near the shore, the more you cover the entrance as a cover the better?—Of course it is, but Plan No. 1 has a more accessible entrance than No. 2, I think, as regards navigation. Of course that is a purely nautical question which I have not gone into, but it might be desirable to flatten No. 1, although not to the extent shown in No. 2.

3007. (*Chairman.*) This plan before me is marked No. 4, and it is condemned because the angle of the covering arm is so great that it is thought that the sea during a north-east monsoon would run inside it. Is not that angle and the angle of the outer part of the inner covering arm in No. 1 pretty much the same?—Not very different. But I have already said that Plan No. 1 appears to me to be rather too open, and so does No. 4. But there is another objection, as it appears to me, to No. 4, and that is the funnel-shaped mouth which will raise the sea tremendously in there.

3008. That plan is condemned, and that was a part that they objected to, that this angle at the covering arm admitted too much sea in a north-east monsoon, but the funnel-shaped mouth was their radical objection?—I should quite concur in that objection.

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3009. You say that it would take about a year-and-a-half to reconstruct the south arm up to the old entrance?—Yes.

3010. You have said before this, in answer to Sir John Coode, that the time necessary to leave the two entrances open would be from one to two years; that is in your former evidence?—That was referring to No. 1, that the removal of so much as would be necessary, would take from one to two years.

3011. Do you not think that, supposing No. 3 Plan were to be adopted, enough of the rubble could be cleared away to open a sufficient passage for ships in about the same time, leaving at the outer end enough to make an entrance of, say, 500 feet?—But that is not 500 feet of clear opening. If it is 500 feet in the line of the pier it cannot be considered more than 300 feet in the line of navigation.

3012. There is that difference. To make a 500 feet opening you would have to take up more than 500 feet of bank, no doubt?—No doubt that entrance might be used before the removal of it was quite finished; but I imagine that the continuation of the south arm crosses over the old pier-head. I hardly know whether that could be called an advantage or not. I do not know that it would be any material difficulty, though it would not be of much advantage.

3013-4. (*Sir John Coode.*) It would not affect the question either way?—No. Perhaps the Committee will now allow me to say a little about the general policy of changing the entrance rather, in view of Captain Taylor's evidence, because that has been, I think, very valuable to the question, inasmuch as it shows what his idea is of the advantage of the change. I was under the impression, until I read what he said the other day, that he considered that with a change in the entrance the harbour would be secure for vessels to lie there in any weather. But it seems that he does not now endorse that idea, and he thinks, as almost all other captains have done, that in an extreme case a vessel should leave the harbour. Then, if that is the case, the whole of the advantage of this alteration seems to me, as Captain Taylor himself admits, to centre upon the greater facilities that he would get for landing and shipping goods upon the beach. He says that occasionally they are now blocked up on account of the great height that they have to land the goods or lower the goods from the screw-pile pier. I do not know whether the Committee is aware that at this time the whole of those goods are landed and lowered by the most primitive hand-cranes. There is not a bit of steam used upon the place. If they were properly supplied with steam cranes of a suitable kind or possibly hydraulic cranes, it would make an immense difference. The conclusion that I came to was that steam cranes would be better here, but with either steam or hydraulic cranes I have no hesitation in saying that the work at that pier could at once be trebled. The necessary accompaniment to that would be the alteration of the railways; they must be changed from the 5 ft. 6 in. gauge which they are now, in connexion with no railway whatever, to a metre gauge which might be in connexion with the South Indian Railway. That would enable them to put six or seven lines of rails upon the pier instead of four as at present, and to have two spare lines for empty trucks. With such an alteration as that, I repeat that I believe the work in the harbour could be trebled; but then there is another difficulty which I think is really quite as great a one as that in the present state of the harbour, and that is, the impossibility of having any vessels about there that cannot be beached, and beached easily. Captain Taylor proposes spending 20 lacs of rupees in order to bring that beach in the inner part of the harbour into a state in which large lighters, steam tugs, dredgers, and all kinds of vessels can remain afloat in safety, or small vessels at any rate. So far as I can make out that is the only advantage which Captain Taylor proposes from this great outlay, and I am perfectly certain from the estimate that I have made that for one-tenth of the money the whole of these advantages could be given by a boat harbour in this reclaimed land. I do not think I need waste your time in saying much about the idea of the impossibility of keeping an excavation open without a concrete bottom or a concrete side, and that sort of thing. We know perfectly well what it is there, and that there would be no difficulty whatever in excavating it by hand down to low-water mark and dredging it afterwards to, say, 6 feet in depth, which would take steam tugs or small dredgers or any amount of lighters, and if it was required the whole of the land side could be fitted with wharves to which those boats could go.

3015. (*Admiral Sir George Nares.*) You do not, I presume, question the advantage of obtaining as smooth water as possible inside the harbour?—The smoother the better, but for 350 days out of the year the water in the harbour, as it is at present, is quite sufficiently smooth for all purposes of loading and unloading.

3016. But for the other 15 days some security must be given to the lighters in some way or other?—That is an absolute necessity for those exceptional days, in order that they may keep upon the spot large lighters and craft of other kinds that are necessary for doing the work of a large mercantile port. I have not mentioned yet the plan that has been put before you for a ship dock, because I look upon that as a thing quite in the future.

3017. (*Chairman.*) There is an inconvenient question about the sand there. One of the witnesses said in answer to Sir John Coode, that there is no foundation; the fact is, that the sand on that coast and the water are almost equally mobile; the sand moves about almost like the water?—Yes, and that it would require concrete bottom and concrete sides.

3018. You mean for any such basin as you propose?—Yes; I do not at all understand that theory. Captain Taylor speaks of the difficulty that Mr. Thorowgood had in getting an intercepting drain along the shore, but there he had to lay the trench dry in order to make the drain. In the case of this boat harbour, everything that is excavated under water would be done by dredging. It would be utterly impossible to advise, at any sort of reasonable cost, to "unwater" it, or to keep the water out of it; and how Captain Taylor's concrete bottom is to be put in, I do not know.

3019. (*Sir John Coode.*) Do you propose any concrete?—No concrete at all.

3020. How would you line the basin?—I would leave the sides of the excavation to take their natural slopes; there is plenty of room there. It might be desirable, perhaps, to steepen them with laterite, but that would not form part of my plan.

3021. Then you do not propose, as I understand, to use the sides of that basin for wharf purposes at all, because, if so, you would surely require something much steeper than a sand slope?—When wharfage becomes necessary, I would make a pile wharf. I do not propose to have any concrete there at all.

3022. Therefore Captain Taylor's objection to concrete falls to the ground?—Entirely; but he suggests concrete as a way of getting over the supposed difficulty as to the bare sides. That is a thing which would never enter my head. I cannot see the slighest difficulty in opening a boat harbour in that land. As soon as ever the shelter is sufficient to enable us to keep the entrance open, we can put an overlapping arm. That struck me as rather important, because as I read Captain Taylor's evidence, the object of this grand scheme is to get more facilities on the beach.

3023. Certainly that was the great object he had in view. His idea is that by the construction of jetties from the shore along the whole length between the two piers he would thereby add very greatly to the facilities for carrying on the trade of the harbour of Madras, which he says they cannot now do by reason of the disturbance?—My answer to that is, that it can be done by simply altering and improving the arrangements at the present screw-pile pier.

3024. Do you think that one pier would be sufficient?—Yes, I think it would; its efficiency would be trebled by putting steam upon it; and then, if further extensions are wanted in the way of jetties, they could surely be made in the boat harbour.

3025. Could not you also extend the accommodation by putting out another jetty or two on each side of the existing jetty?—That might be done, and that is what was originally intended to be done, but Captain Taylor's great object is to have a low-level jetty, so that the coolies can work in and out of the boats without raising or lowering the cargo. But that, I think, is a fanciful requirement, and steam cranes will perfectly annihilate height and depth.

3026. Still, if you think that extending the jetty could be made of such great advantage by the introduction of steam cranes, and it were found that that

nearly poisoned Mr. Thorowgood, and all his people in his offices; but, as I say, it is generally opened at night, because the municipality do not wish to inflict more misery on the people than they can help.

3085. May we take it that the water is always so much discoloured that you can scarcely tell the difference when the rainfall is being discharged or not?—I am afraid I cannot follow your question.

3086. The rainfall is generally discharged outside the harbour on the north, is it not?—It is, on the two or three days in the year when there is a heavy rainfall.

3087. When it does discharge, if the sea is discoloured considerably, on which side would you notice the difference?—We notice it chiefly by the smell.

3088. Not by the sight?—Not by the sight.

3089. Therefore we may take it that there is considerable discolouration of the sea during the northerly monsoon?—No, not always, but for a few days in the year only.

3090. (*Admiral Sir George Nares.*) The southerly current passing the east face of the harbour must strike the land somewhere to the north to scour out the sand on the north side and carry it northward; do you think that it would strike anywhere south of the railway works?—It comes right into the corner.

3091. It runs at present along the north pier, and curls right round there?—Yes, it curls round on to the revetment and the railway company's beach.

3092. But with strength sufficient to carry the sand along?—With strength enough in stormy weather to displace the stone of the revetment. It is almost impossible to give you a clear idea of the thing without seeing it. On this particular occasion, the revetment was washed away in many places; in the case of the Sailors' Home all the wall was gone, and the sea came up within a few feet of the house itself.

3093. There is no doubt whatever of the movement of the shore; but what I cannot understand is, how that small amount of sand that is lodged in the corner between the north side of the north pier and the railway jetty can possibly be carried northward by the southerly monsoon current striking round there?—I do not know how I can convey my opinion in any other language than that I am certain it is so. The tendency of the groynes on this coast is that, after the sand is deposited on the one side of the groyne, the waves cut close round; so much so that you could keep the mouth of the Coom open there, and you could keep the canal open there by choosing a proper position for the groynes. Of course, after a time it would require to be extended as nature does at Pulicate and Armoghan. But the main point that you want first of all to consider is this: I am morally certain that there would be no difficulty whatever in using the north entrance instead of the east. You would get smooth water during which they could conduct their operations. It would be a great improvement to the trade, and greatly increase the prosperity of the town, and they could increase the harbour if they wanted it in that way further north by merely extending the sea face groyne and running another one out parallel to the present north one. In no other way could any improvement to the Madras port ever be carried out.

3094. (*Sir John Coode.*) Do you think that the trade which would arise could be carried on much better by jetties projecting from the shore or in the boat harbour as suggested by Mr. Parkes?—You could not carry on trade there because all those houses on the shore are occupied by merchants and people of that class, and you would have to cut away all this wall to bring it there (*pointing to the plan*).

3095. You could make an opening through it, could you not, and so get an opening into the boat dock?—Yes, I should say that that would be the worst thing that could be done for Madras.

3096. Why would it be the worst thing that could be done?—Because we could not utilise this space again; (*pointing to the plan*) if you put a dock to the south there would be no room to carry on the trade of the port. The road comes right along here (*pointing to the plan*) and along the beach between the two arms where the road is open, there is an ample space without interfering with anything else, but we should have to buy up the whole of these houses there, and then we should not be able to utilize this space.

3097. Mr. Parkes proposes to make this new dock on the sand which has accumulated on the newly formed area; what do you say to that?—We do not want a dock there. We want to carry on the trade along the beach between the two arms. It would be impossible to carry on the trade in a basin formed there, as Mr. Parkes suggests, because it is all sand. I do not believe that any engineer would ever be able to make it. You would come to water in about two feet, and the moment you attempted to clear it away, the sand would come up and the water with it, and you would require a concrete basin.

3098. Mr. Parkes says no; he says he would merely excavate a basin by dredging operations, and if necessary would provide landing accommodation by means of timber sides?—Then I can only say that the first rough weather that came, the sea and the basin would be amalgamated at once.

3099. They do not now?—No, there is nothing there now.

3100. But he proposes to make this inside of a strong foreshore?—There is no strong foreshore there. The road comes right up to the foreshore. The only thing that he has got is sand, which he says must be accumulated there, and if he ever should make a dock out of it, it would be certain failure. If you laid a puddle down there the moment that the rough weather came, and the sea and this puddle came together, the same thing would happen.

3101. But this is gradually growing seawards, is it not?—No, I say it is stopped, and Mr. Parkes says so too, at least it is so far stopped that no sands are accumulating here, but outside, as at Pulicat and Armoghan.

3102. What say the soundings?—I think Mr. Thorowgood says that they are not reliable.

3103. But he sends them home for our information?—I know he told us that he could not depend upon the soundings which were taken by his surveyors, the sea not being smooth enough.

3104. He does not pretend to say that the soundings above the 2-fathom line and below the 2-fathom line where the surf is breaking on the surface are reliable, but we have got contours showing that it is shoaling gradually?—It may be shoaling gradually, and, if so, then we had better wait for another 20 or 30 years before we make a dock. As it is now, near as it is to the sea, I have no hesitation in saying that it will be all knocked into a cocked hat the first rough day, unless you put a sea face to it which was nearly as strong as this one; but that would be altering the whole trade of the port. At the present landing place we have no occasion to alter anything; we only want smooth water.

3105. You say, generally, that with smooth water the best possible thing that people can do would be to carry on the trade along the beach between the two piers?—Yes, with horizontal quays or jetties, and to dredge them out if the silt should cause any interruption.

3106. You think that is the best mode of carrying on the trade of the Port?—Yes, as the trade is now.

3107. Supposing that Mr. Parkes should succeed in making this boat-basin, what should you say?—That it would be of no use; boats would not go in except in bad weather. It would be a refuge for boats in bad weather, and a most expensive refuge too. The present system of warning them would be better than that, but I have never heard of any definite plan. I know that Mr. Thorowgood once spoke to me about Mr. Parkes' idea; but you cannot move the trade of the Port down to there; you cannot shift it; there is no room there.

3108. (*Chairman.*) Have you any data by which you can tell us at what time you expect this 4-fathom line to reach the corner of the South Pier?—I do not think it ever will, but I think that a sand bank on the Knuckle will form instead.

3109. (*Admiral Sir George Nares.*) Have the soundings that have been obtained ever been plotted by the Board of Trust to see the rate of advance?—No; they have no establishment to do that. They pay the harbour engineering staff for that; but if anything can show more strongly the fallibility of soundings here it is the fact that all these extraordinary changes have taken place in the course of eight years.

3110. (*Sir John Coode.*) You rely for soundings upon the harbour staff, do you not?—No, I do not entirely; but I have no occasion to use soundings at all.

3111. You have no occasion to use soundings, but would you rely upon their accuracy?—I would rather go and take them myself.

3112. Supposing that the soundings showed the existence of a certain state of things, would you dispute that?—No, I have no occasion to dispute it. They can only show one thing, that there is an accumulation on the south side.

3113. Supposing that all the soundings show, as they do, that the 4-fathom line is advancing seaward at the rate of about 80 or 90 feet a year, what would you say then with regard to the time when this would reach the knuckle?—As I said before, it would stop when the current came from the north in the four months of the northern monsoon, just as it does with all the groynes on the coast; the moment it reaches anywhere near the top the other current clears it away so far, but the accumulations come out here instead (*pointing to the plan*).

3114. But the soundings show, do they not, an annual accumulation there?—They will show it very soon, if they do not now. We have got to look to posterity more than to the present; and if a generation hence it is found that the whole thing is spoiled from neglect of a simple observation like this, which you could exemplify in a dozen other parts of the coast, we should then be in a very awkward position.

3115. According to the soundings which are before us now, this 4-fathom line is going steadily seaward?—It cannot go beyond the angle, because it comes to the same condition that the land did before.

3116. When it arrives at that point, would there not, on the occasion of a prevalent surf on the beach, be a quantity of sand in suspension to be carried up and down the coast?—I do not agree with that at all. I agree that the operation north would be the same as we have observed on the other parts of the coast after reaching a point somewhere near the angle; and if you say it is altering fast, then sandbanks will form out on the angle like they do at Pulicat and Armoghan.

3117. Then it will have a quantity of sand ready to be disturbed and carried north?—It will not interfere with the north; it will go away to the north-east. If you look at every port on the coast, you will see that the sandbanks all trend to the north-east.

3118. (*Admiral Sir George Nares.*) Fifty years hence, what depth do you expect at the north-east of the entrance?—The same as there is now, eight fathoms; the contemplated entrance is in about eight fathoms.

3119. If the four-fathom line, the three-fathom line, and the two-fathom line are going to advance out to the end of the south pier in the course of 50 years, what depth of water do you expect there will be at the north-east entrance?—The same as there is now. I expect that the surplus sand will go away to the north equally as it does at all other parts of the coast.

3120. Just now you gave us the southerly current as sweeping out the sand all along the north pier; would not the same effect remain?—My experience in other parts of the coast is that it does not do so; as to this it is purely a matter of speculation.

3121. Excuse me, it is a matter of your evidence?—My evidence is simple enough.

3122. Your evidence has been this, that the south current is so strong at the back of the north pier as to scour out the sand all the way along?—I never used the word "strong." You say there is a little sand at the end of the pier, but I say that in the storm the other day the current carried away the revetment in this bight by a northerly current, but it did not carry it against the harbour wall.

3123. I cannot see what is to prevent the north-eastern entrance silting up in the same way as the shoal is formed at Pulicat, and at that place north of Armoghan?—I have had nothing to do with them, but look at Pulicat and Armoghan, as there the entrance is kept clear from the north.

3124. Excuse me, the chart shows very differently?—I have been very often there myself, and I always understood ships getting ashore on the Pulicat had come down inside, that being the result of close observation for many years.

3125. (*Chairman.*) Some of the nautical witnesses object to the north-east entrance more, because it would be difficult to get out than because it would be difficult to get into it in bad weather?—I can only say that in our opinion they are wrong, and in bad weather I hardly know what they can be acting upon, because if your ship is head to the wind, and if you can get steam upon her there is no difficulty.

3126. How do you propose to moor?—When we go to sea the question of mooring does not enter into the calculation, because you can warp out of that position to get out of the harbour to a buoy or anything. If we pack them as close as we propose to do there, we should require a ship to go under her own steam from the berth through the mass of shipping out to the entrance; we should probably warp or tow her out to a buoy in a commanding position. That is what they will have to do at Bombay in the Prince's Dock. Then the P. and O. captains tell me that that dock is a different thing from any open basin like this has been hitherto. We do not ourselves think that there will be any difficulty whatever, and that for nautical questions we shall not ask the captains to bring the ships in and out. The pilot will do that; in fact, the captains are not required to do so. It is compulsory pilotage.

3127. You do not think that the number of buoys in the harbour itself must prove dangerous to the shipping under those circumstances?—I do not wish to go in for a number of buoys. That was a very great mistake which was made in the original design of the harbour.

3128. Where do you propose to make your warp fast?—To a single screw buoy. Mr. Parke's plan is to have four moorings that will cover the whole harbour.

3129. And that you object to?—Yes. If we got smooth water we could do as they do at Malta or at any other port. You could put down a screw pilot, and put a buoy to it.

3130. I am speaking about clearing the harbour when warning signals are hoisted?—At that time of the year the weather has been anticipated for many days, and most ships go. Probably there would be only two or three left who were very anxious to complete their discharge or their lading, whichever it might be, and the harbour would be comparatively empty.

3131. Yet some of the witnesses say that occasionally they have only had two hours warning?—There has been no warning absolutely given; but in the afternoon, if the weather looks unsettled, I think I said in my evidence before that notice is sent round to the captains, that judging by my experience I should rather be outside than in, but if they like to stay they had better keep their steam up. If there is a storm coming, we give a regular warning. The only occasion on which that has happened has been when a storm was gathering. Last November when there were two steamers that could not get out at the Eastern opening without the greatest trouble, they could have got out at the north easily enough. But it is not a nautical question, for in Madras we are perfectly satisfied, and it is a great pity that it was ever incorporated with the scheme at all.

3132. But it is the nautical part of the question which is specially before us?—It is a great pity that it was ever brought before you, because it is really the quietest place in the world almost, except during a few days when cyclonic weather is expected, and then, as I say, all the ships must be treated exceptionally.

3133. Speaking as a sailor myself, I ask you the question with regard to pointing the ship for the entrance, not as to what you do when you get outside?—I would much rather go with my head against the wind.

3134. And the wind is on those occasions to the north-west?—To the north north-west to N.N.E.

3135. We will suppose that you take a ship from a berth on the north side of the harbour—I do not know whether this plan fairly represents the moorings as proposed?—That is the old plan. There is no room for ships to swing now, as Mr. Parkes contemplates. All that you have to do in that case would be to drift down to the middle of the harbour and drop anchor.

3136. Supposing you drop down to a buoy, there you might foul the screw?—We should take care of that. This has been one of the greatest mistakes connected with the harbour that with this system of bridle buoys it could not be done—it would effectually spoil it; but still if we had a place as quiet as a dock, which, we should have with the sea-face closed, it would not make so much difference.

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3137. You say that it is not a nautical question; supposing that when the pilot was in charge of a ship and is taking her out of the harbour in bad weather, or when bad weather threatened, and anything happened to the ship, would the port trust be responsible to any extent?—Not more than any other harbour trust.

3138. And therefore it does become a nautical question?—Except that the captain has no control over his ship. There is a pilot who takes him in and out. It is the same in every harbour; there is no exception in the case of Madras.

3139. Except that in Madras you are dealing with an exceptional harbour in what you may call exceptional weather?—No; we should not call it an exceptional harbour. If we had the sea-face closed we should think that we had a fair small harbour; that is our view of the matter. Things that we cannot do now we could do then.

The witness withdrew.

Adjourned.

At the Board of Trade, Whitehall.

Thursday, 7th July, 1887.

PRESENT:

VICE-ADMIRAL SIR NOWELL SALMON, V.C., K.C.B., IN THE CHAIR.

REAR-ADMIRAL SIR GEORGE NARES, K.C.B.

SIR JOHN COODE, K.C.M.G.

MR. F. C. THOMSON (India Office), *Secretary*.

Mr. G. W. Lowe.

7 July 1887.

MR. G. W. LOWE further examined.

3140. (*Chairman.*) You gave us some evidence about the currents the last time you were before us, and we want to know if you have made any observations as to the current removing the sand from the north side of the harbour; in fact, which way does the sand go, to the north or the south?—Since we ran the arm out there is no sand goes away from the north side at all. Indeed there is no sand comes nor goes to the north side now, not alongside the wall.

3141. Does the northerly current during the north-east monsoon strike the inner corner of the northern breakwater and sweep outwards?—Yes.

3142. And in the south-west monsoon does it take the opposite direction, or does it miss the corner altogether, as a rule?—It is perfectly sheltered on the north side then; it is perfectly still water.

3143. Then you think that the current which did remove the sand was a northerly current, and that the sand passed away to the southward?—Quite so.

3144. Do you think that the current which now sweeps round the bay formed by the northern arm of the breakwater is ever laden with sand now?—Not on the north side of the bay.

3145. Will you look at plan No. 3 and consider that the red protecting arm is produced to double that length. Do you think that there would be any danger of the silting up of the sand in the mouth protected by that arm?—No, since we run the south arm out, there is no removing of the sand on the north at all.

3146. Then the erosion that took place on that north shore all took place before the harbour was completed?—No, there was some afterwards. Since the harbour works were completed there has been no action of the current nearer the harbour works than the Sailors' Home, about a quarter of a mile to the northward.

3147. But there would appear to be a current from the southward?—Quite so.

3148. Has the current from the northward now no effect upon that shore?—No, because we have got a revetment all along the foreshore.

3149. For what distance?—For quite a mile.

3150. Have you ever seen any deposit of sand upon that revetment?—Yes.

3151. In the north-east or in the south-west monsoon?—In the north-east monsoon.

3152. What becomes of it?—It goes away when the land wind sets in in July and August.

3153. (*Admiral Sir George Nares.*) Is it washed down from the revetment into the sea without going north or south?—Yes, without going north or south; it forms a bank outside about half a mile out.

3154. (*Sir John Coode.*) Do you mean to say that it is clawed off by the land wind?—Yes, there is a great deal of ground surf in there.

3155. That being the swell which accompanies the land wind?—Yes, with the land wind it is a regular sea.

3156. The swell during the land wind is very heavy, is it not?—Yes, it is heavy.

3157. (*Chairman.*) Supposing an opening to be made at the north-east corner, the choice appears to lie between those two plans, 1 and 3; have you seen them before?—I have not seen those plans. My son wrote to me and just scribbled me down what he thought it was to be.

3158. The principal difficulty in such case would appear to be the removal of the old work; is that your idea?—That would be a difficulty, but not the principal one.

3159. In the case of plan No. 1, it is proposed to complete and re-construct across where the entrance would be, and to remove it again, after the whole of that north arm is completed, to the old entrance to the harbour; and in the other case, it is proposed to stop the work where it now is, and complete the sea face from the south side entirely; the effect of that would be to open up a north-east entrance before there is any protection on the sea face more than there is at present; which plan should you prefer?—If I was bound to take one I should prefer No. 3.

3160. Would you give us your reasons for that?—One reason is, that I would take all the curves out from the seaward front of the work, and make it straight; and another reason is, that it would come just to the end where the work is now, which would be another advantage.

3161. Then the disadvantages are said to be that there is a greater length of work to be picked up in the case of plan No. 3, and that you have no fixed platform for doing it from?—In that case, of course, it would be expensive in whichever way you do it.

3162. Would you compare that work with the work that would have to be done in removing the finished pier in No. 1, with the assistance of the titan. It would have to be done principally by divers in removing the wreck of the old breakwater, and also the additional rubble which has since been laid to the point at which the re-construction works have now arrived, to a point very near the present entrance; would you compare that with the removal of the completed work as proposed in No. 1?—I would certainly have the titan there to do all I could with it.

3163. That is to say, putting the shape of No. 3 out of the question, you would prefer plan No. 1?—Yes.

3164. (*Admiral Sir George Nares.*) Is there any other means of picking up blocks than by means of the titan?—No; not in water like it is in Madras. If it was still water, so that we could have floating craft, as they have at Alexandria, then we could pick them up without the titan, certainly; but they would not answer in Madras.

3165. At Madras you must have a fixed platform to work from?—Just so. One or two blocks may be picked up; but not such a quantity as there are to be picked up there.

3166. (*Sir John Coode.*) How many days in the year do you think it would be possible to employ a floating crane at Madras?—Not more than two months in the year.

3167. Would it be every day for two month?—No.

3168. And it would be liable to breakdowns?—Yes.

3169. Then in the two months, how many days' work would you say?—They may be at work for a whole week right off in January.

3170. Then whichever of these plans, No. 1 and No. 3, might be adopted, I understand your evidence to convey to us your opinion that in either case you would completely construct the work, and then remove the blocks and the rubble by what we call the back-handed process?—I certainly would, if I had my way, whichever plan was adopted.

3171. Is it your opinion that that mode would be the most economical and the most expeditious?—Yes, it would, by a long way, I am sure. If I was going to take it into my own hands to-day I would certainly do that; it would be safe and expeditious.

3172. In fact, it would be the safest, the most expeditious, and the most economical mode of proceeding?—Quite so.

3173. While you were constructing the north pier, did you find much current running alongside with you at the back of the north pier?—A great deal.

3174. For how far at the end of the work; for the whole length, or for a portion of it?—About 600 feet.

3175. Was that the first 600 feet from the sea?—Yes.

3176. After that did the current disappear rapidly or gradually?—It was only occasionally that we had the current afterwards.

3177. But up to about 600 feet it was almost constant in both monsoons?—Yes, but that was because we did not have the south arm at all.

3178. In the earlier stages of the work the north arm was considerably in advance of the south, was it not?—A great deal.

3179. When you found that current, was the water thick and sandy?—Yes, I had to take up the sand before I could set the blocks on the rubble base.

3180. You are speaking as regards the quantity of sand lying on the surface of the rubble; my question was rather pointing to the quantity of sand in suspension in the water?—It was quite full of sand.

3181. Was there anything beyond that?—We did not suffer afterwards.

3182. Was it from 600 feet out to the end clear of sand?—Yes, there was a little darkish water, but not anything to settle.

3183. Do you believe that there is now any current prevailing along the back of the north pier?—There is.

3184. And frequently occurring?—Not constantly. I cannot understand why the current sets in there, but sometimes when there is not a breath of wind, there is a strong current on there.

3185. In either monsoon?—Mostly in the north-east monsoon.

3186. Do you find it occasionally during the south-east monsoon?—Yes.

3187. Could you give the Committee any opinion upon this point. It has been suggested to us, that if the work were constructed in such a manner that there was an overlap to the north-east entrance, there might be a danger of vessels being driven on to the overlapping arm by the current at the back of the north pier; do you think there is such a current as would do that?—I do not think there would be that risk; at least the ship would be stopped along the foreshore.

3188. Take the case of a vessel attempting to enter that opening and being driven by the current to the back of the north pier on to the overlapping arm; do you think there is such a current as would have that effect?—Yes, upon times there has.

3189. How frequently do you think?—Mostly when the land winds are on, that is in July and August.

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3190. You have been in and out there in diving boats frequently have you not?—Yes, hundreds of times.

3191. Did you ever experience anything in the shape of a current there that would set you seaward?—I have many times been obliged to get the divers up.

3192. Was that current setting round the end of the work?—It was setting into and round the end of the work.

3193. It might have come from the seaward, might it not. We have been told that there is a current occasionally along the back of the north pier?—There is.

3194. And we have been told also that there will always be a risk, greater or less, of a vessel attempting to enter the north-east opening, being driven by the current on to the over-lapping arm; do you think that there would be a risk of that?—Yes, there would be a risk when the current is on.

3195. (*Admiral Sir George Nares.*) When the current is on, is it not generally cyclonic weather?—It is so very strange there; it does not come in regular seasons at all; it is mostly when the land winds are on.

3196. (*Sir John Coode.*) With the wind with a little north in it or a little south in it, which would create the worst current, do you think?—The heaviest current is when the wind comes from about north-west, it strikes the foreshore and strikes right out.

3197. Do you, or do you not, feel quite clear about there being a current at the back of the north pier with a south-westerly wind?—Not so much.

3198. Is there any with a south-westerly wind?—Yes, there is a little.

3199. Which is the worst?—The worst is when it is north-west.

3200. (*Admiral Sir George Nares.*) The sea outside would come slightly from the northward?—Yes.

3201. (*Sir John Coode.*) Do you think that it heaps up at the back of the work, or how?—It strikes the shore to the northward of the town of Madras, and then runs along the shore and down past the rubble foreshore to the back of the north pier, and along the pier itself.

3202. I suppose Mr. Thorowgood would, perhaps, have as much experience of that as any man, being constantly on the work?—Yes; I was on that wall from morning till night.

3203. (*Admiral Sir George Nares.*) With this northerly current outside the north pier is the water discoloured?—Yes.

3204. And discoloured for the whole length of the pier?—For half a mile outside the harbour.

3205. Then there must be sand in supension in the water?—There is a great deal; it is coloured quite red from the rubble base from the laterite.

3206. (*Sir John Coode.*) Did you see that up to the time you left Madras?—Yes.

3207. Is that the laterite along the shore?—Along the revetment.

3208. You have not much laterite in the foundation of the work, have you?—Yes.

3209. (*Admiral Sir George Nares.*) Would the discoloration be caused by the water coming out of the town drains or would it be actual sand in suspension brought along the shore from the north?—Both.

3210. Is the water as discoloured with the northerly monsoon as it is with the southerly monsoon?—Yes; rather more with the north-east monsoon.

3211. In fact, except in the calmest weather, there is always discoloured water surrounding Madras harbour?—There is only about two days in the year that there is what we call clear water.

3212. Is it so discoloured that it is inconvenient for your men to dive?—Yes, they cannot see at all, only a very few feet from them.

3213. You say that the sand did not collect on the rubble base after you got out a certain distance with the piers?—Not at 600 feet.

3214. Was that in consequence of the flow of water over the top of the mound being sufficient to prevent the sand from depositing itself on the mound?—No; because we ran the south arm out, and there was no sand that came from the north. All the sand came from the south, and in the south-west monsoon before the pier was built it used to come back again.

3215. Then there is a disturbance of the sand at the bottom of the sea for the whole depth surrounding the harbour?—Not after you get 600 feet out.

3216. But if the water is discoloured, is the current disturbing it at the bottom, or is it only being carried in suspension?—Only being carried in suspension; that is my belief.

3217. Do the divers find the sand at the bottom in motion?—Yes.

3218. Would it be in motion for the whole length or outside the north pier?—Not so much to the north as it would be to the south.

3219. If any material were left on the sand outside the north pier, would you expect to find it there again the next morning, or would it be covered?—It would not be covered as soon as that.

3220. Then there would not be much motion of the sand there?—No.

3221. (*Sir John Coode.*) Do you think that the sand that was found in motion by the divers to which you referred just now, in answering Sir George Nares, was due to the obstruction of the diver's body; do you think that if the divers were not down there, there would have been so much sand in motion?—There is no doubt that excavating and making the bed would make a great deal of movement.

3222. The mere fact of the divers going down on the sand would cause disturbance?—Of course it would.

3223. Do you think that if the divers had not been there the sand would have been visible, or that there would have been sufficient sand moving for you to observe it?—There would have been a little, but not so much by a great deal. It is very seldom that we have got clear water in Madras; there is a sort of little sand or shell always moving in the water

3224. How far out?—Out as far as ever we have been.

3225. And could you see the discoloration outside?—Yes.

3226. Could you see the margin of it?—Yes, about half a mile outside the harbour.

3227. Do you think that this discoloration would extend as far out as half a mile?—Yes; but not continually.

3228. Is it a matter of common occurrence?—Yes.

3229. Could you give us an idea how many days in the year?—I should say three months out of the year, but not continually.

3230. You mean to say that something like 90 days out of the 365 days the sand would be discoloured?—Just so, but it would not be continuous.

3231. You have conveyed to my mind that this discoloration is mainly due to the laterite along the north shore?—And to the current running along the shore.

3232. And the current conveying the matter from the laterite more than from the sand?—And the sand along the shore as well.

3233. What proportion of this discoloration do you think would be due to sand, and what to laterite?—The proportion was very small.

3234. How far out did you find any material quantity of sand in suspension?—We did not find a great deal after four fathoms depth.

3235. Did you find it out to about as far as four fathoms?—Yes.

3236. Did you find a sensible quantity?—Yes, about a couple of inches; that was when the surf was on. We did not have walls at that time, and there was no protection at all; it was before we ever built the walls.

3237. (*Admiral Sir George Nares.*) Two inches in what time?—I should say it was about two months.

3238. (*Chairman.*) You gave evidence here before, did you not, that dredgers could not be employed in removing the rubble for more than two months?—Yes, about that.

3239. Principally in February and September?—Yes.

3240. Would it be worth while having dredgers out for those two months?—I do not think it would.

3241. The proportion of work that the dredger could do in these two months would not make it worth while?—If all the blocks were clear she would certainly pay herself in two months.

3242. We have had so much evidence since you were here before, pointing to the weather at Madras being as a rule very fine, and the sea being so very slight under ordinary circumstances, that I should like to ask you whether you are inclined to modify your answer at all about the two months?—That is the best two months that we have in the year so far as our work is concerned.

3243. You still adhere to that?—Yes.

3244. You also, in your last evidence, spoke of having seen the sea strike the platform of the titans. With a re-constructed harbour works, which will be built 6 feet higher above the sea level than at present, would that be sufficient, do you think, to give shelter to the small craft inside, which we know were all wrecked before the harbour was destroyed in that cyclone?—It would certainly, and more so now by having the wave breakers outside there.

3245. (*Sir John Coode.*) It was suggested at one time that the wave-breakers at the back of the north and south arms were really not required, do you agree with that view?—No. As soon as ever that plan came out, I said, that is just what we ought to have had when we started; and if we had had it we would never have been knocked down, that is, if we had had wave-breakers.

3246. What was the length of the wave-breakers when you came away?—1,500 feet.

3247. Both on the north and south piers?—On the north pier it was 1,500 feet, and on the south pier it was about 1,000 feet.

3248. And were you satisfied that those wave-breakers were having a beneficial effect?—Yes.

3249. Putting aside for the moment your opinion as to what the effect would be, I may ask you what was the effect?—You could work on the wall where you could not put a foot before.

3250. Then you are satisfied that the wave-breakers along the north and south arms have been of considerable benefit to the work?—Certainly.

The witness withdrew.

Captain ROBERT LAURIE TURNER examined.

Capt. R. L. Turner.

3251. (*Chairman.*) You are in the service of the British India Company, I think?—Yes.

3252. And you have been constantly in the habit of visiting Madras?—Yes, I have been in coasting steamers there over 20 years, although not continually going to Madras.

3253. You knew Madras before the harbour was thought of?—Yes.

3254. Did you know it when it was completed?—I was never in it while it was a harbour; that is to say, from the time of its completion until it was washed down.

3255. You have also visited it frequently since?—Yes, I have been eight times there within the last 12 months, having made four voyages to Calcutta.

3256. At the best of times did you gain any great advantage from the harbour?—No, I do not think so.

3257. The state of the sea inside the harbour is, generally speaking, almost as bad for loading and unloading as the sea is in the roads, is it not?—Yes.

3258. Is that in your opinion due to the opening being in the eastern face of the harbour?—Yes, partly due to that, and partly to the broken state of the breakwater. The sea comes rolling in between the stones and makes it very choppy for the slight masoolah boats to lie alongside the ship.

3259. When the harbour was at its best, so far as you knew it, the disturbed state of the water was due almost entirely, was it not, to the sea entering the entrance?—Yes, right opposite the pier.

3260. Do you think that the reconstructing of the harbour, and closing that entrance, and opening one to the north-east, would make any very great improvement in the harbour?—I do; I think it would be as smooth as a dock.

3261. Would it make any difference, do you think, in the case of taking a vessel in, or, in the case of storm warnings, taking a vessel out of the harbour?—I do not think it would be any more difficult, in fact, I think it would be less difficult with an entrance to the north-east. Storms generally come from the north-east, and you go out head to sea and head to wind more than you do now.

3262. In fact, you appear to think that a north-east entrance would have every advantage?—Every advantage, I think. Smooth water is what we require. We lose a great deal of cargo overboard as it is now through its getting knocked out of the slings by the boats bumping alongside.

3263. Do you ever unload outside to the north of the harbour?—I have partly unloaded outside when the harbour has been full, and I have had to wait for a ship coming out to make a berth inside.

3264. Is the water deepening or shoaling, or do you think there is any alteration in the soundings?—There is an alteration in the soundings to the northward.

3265. Can you show me on the chart about where that has taken place?—Somewhere about half a mile to the northward of the knuckle of the north arm. I anchored there one night. I had the two titans almost in one. I was inside of the outer line, and I had eleven fathoms of water. We used to anchor in about eight fathoms, I should think. I was coming in by the lead, looking for eight fathoms of water for anchoring, and I found that it deepened instead of shoaling where I usually anchored.

3266. You would gather from that that there is a strong action of the current there?—Yes, I would.

3267. Do you think that that action would have any effect in getting your ship in and out of the north-east entrance?—No, I do not think so.

3268. It would not be enough to be of any consequence?—No, I do not think it would affect us at all.

3269. When you anchored in the place you spoke of, did you see anything of that current?—No, I did not feel it at all in the ship; we laid with our head to the land all night. It was in the beginning of this year, about February.

3270. Will you assume No. 1 to be the plan adopted for the re-construction, with that covering arm carried out as far as may be found necessary; should you not consider that a difficult entrance to take, with a north-east monsoon blowing, and the sea on your beam?—No, the sea would be right aft at such a time.

3271. And with the surf breaking about half-way out the north arm?—I did not see any surf breaking there at all; it does not break any distance out as far as I remember. There is very little surf on this north side now; it is such deep water along the north shore.

3272. Then the surf does not break on the north side of the harbour as it used to do when the sandy beach was there?—No, and not as it does on the south side. I am only telling you what my own observation has been, except that this sand to the south is encroaching very much.

3273. By encroaching you mean going seaward?—Yes, going seaward.

3274. During the north-east monsoon is the sea in the ship felt from the north-east, or is it from the east?—I should say it is about east-north-east, pretty well east.

3275. As there is no separate swell setting the tide on to the shore, you think that a monsoon alters the whole course of the sea?—In the north-east monsoon there is not much sea, but what there is comes rolling in from about east-north-east. There is not much wind, but it is the season when the surf is highest on the beach.

3276. Have you lots of room do you think to keep your ship under command with the engines under the circumstances that I have mentioned, namely, entering in a north-east monsoon and a swell on your quarter?—Yes, I think so.

3277. (*Sir John Coode.*) Do you think 500 feet would be enough?—I do not think the present entrance is too wide.

3278. Do you think that an entrance made to the north-east should be as wide as the present one?—Yes, I should think so.

3279. You would not like to see it even 50 feet less?—No.

3280. You spoke of the choppy sea being very bad for the masoolah boats in the harbour; is it worse than it would be outside?—Yes; I have laid out seaward of the old harbour waiting for a berth, and we have commenced discharging outside.

3281. About how far seaward of the harbour?—About a quarter of a mile—between that and half a mile is a safe berth for a large ship.

3282. Could you discharge a cargo or load out there better than you could in the harbour?—Yes, on that occasion we could.

3283. Then what is the advantage of going into the harbour at all?—I am compelled to go in by the boatman; he prefers the ship being inside in such a sea.

3284. We have been told that the principal advantage was the nearness to the shore; do you agree with that?—Yes, that is so.

3285. Then the shortened distance between the ship and the shore is, if I understand you aright, in a great measure balanced by the occasional choppy sea which interferes with the masoolah boats; do you lose cargo?—Yes, we lose cargo; we do not lose coasting cargo; we lose London cargo.

3286. Is that from the boats getting the goods in slings?—Yes, iron bars, iron pipes, tubes, and things of that sort.

3287. Is that a matter of frequent occurrence?—Yes.

3288. Have you ever experienced any serious loss in that way?—No, not very serious; we get harbour divers to pick them up.

3289. You said that on one occasion when you anchored to the northward, you waited for room to get in; was that on one occasion only?—Yes; it was dark when I came there.

3290. Have you been detained outside for room to get in on more than one occasion?—No, only once.

3291. Have you seen others detained in the same way from want of room?—Yes, I have known them to be detained.

3292. On this occasion when you were detained, how many large steamers were in the harbour; do you recollect?—There were six, I think; there were five in the inner tier, and I think one in the southern corner.

3293. And under those circumstances was there not room for you to get in?—There may have been seven. I could not say precisely; but I could not get in, I know.

3294. Was it your own opinion or the pilot's opinion that it would not be right for you to go in?—There was no berth to put the ship in.

3295. There was water space enough, but no buoy, if I understand you aright?—There was water space enough in the harbour, but you could not moor the ship on account of the block in the entrance.

3296. Were those five or six large steamers as large as your own?—They were of different sizes; it does not matter what size they are, they take up the berth.

3297. What was the largest steamer, do you think, on that occasion, about?—My own ship is about 3,000 tons.

3298. Were there any other vessels in the harbour about the same size?—I cannot recollect that there were.

3299. You said that the worst storms were from the north-east, which is consistent with what we have heard before; but we have been told also that on no occasion does the swell that is coming in vary more than 30 degrees from the east; is that consistent with your experience?—Yes, east-north-east it would be about 22 degrees; it is very frequently east.

3300. We have been told that you never get more than 30 degrees; do you think that, under all circumstances and conditions, you would have no difficulty in getting in or getting out of a north-east entrance?—I do think so; the pilot makes a great deal of trouble about it. I have heard the pilot say it is difficult to get out with a southerly wind; but I cannot see any difficulty myself. I think there ought to be a lot of rings round the breakwater to make fast to.

3301. Do you think that the blocks are sufficiently interlocked and safe to make fast your ship to?—No; I

would place anchors to the westward of the breakwater, with chains lying on the breakwater or through the blocks.

3302. Have you seen any alteration in the character of the sea breaking on the work since the wave-breakers have been put down?—No, I have not noticed it. I have never seen much sea since the blocks have been down.

3303. (*Admiral Sir George Nares.*) Except during a cyclone, the sea at Madras is never too high to prevent your manœuvring your ship with the wind aft, and the sea abeam in seven fathoms of water?—No.

3304. Before entering with a north-east entrance, or with any entrance, you would have to ease your ship, would you not, before going into such a small harbour?—Yes, my custom is to stop the ship altogether, and let her lose her way altogether before the pilot comes on board. I let him come on board dead stop if I can. He has the vessel there lying dead, and he can do as he likes.

3305. And you would not mind taking your ship to the north-east entrance in such circumstances?—No.

3306. Supposing you miss the north-east entrance, is there room for you to anchor?—Yes.

3307. Outside the breakers?—Yes.

3308. Can you give us any idea of the number of degrees that you would be rolling with a good strong north-east monsoon, steering south, for instance, from Madras to the southward?—My ship would not be moving; there would not be sea enough to move my ship if she was under way.

3309. We may take it that during a north-east monsoon the sea is not so very high?—No, it is not as high as all; it is nasty on the beach, but not a high sea, as I said. A light sailing vessel lying outside will roll tremendously with nothing but ballast in her bottom.

3310. But when under way, your ship is comparatively still?—Yes, I do not think the ship I am in just now would move at all; she would come down as steady as a post all the way from Calcutta.

3311. Have you ever experienced any current affecting your entering at the present entrance?—Yes, there is a current which runs across it, and a very uncertain one too; we never know how it is going to run.

3312. Does that present any difficulty at the eastern entrance?—No, I do not think so.

3313. With the present width you can allow for the current?—Yes, you can always see how it is running; there is a buoy each side of the anchorage. You can see by the buoy how the current is going, and you can see by the ships in the outer roads how they swing, and you can make allowance for the current going in that entrance.

3314. With the current from the northward, and striking against the north pier, if the entrance is open to the north-east, would you expect the current to be deflected along the north pier across the opening?—No, I would not.

3315. With the same current that you experience passing the harbour at the eastern entrance now, if we opened the north-east entrance, would you expect it to deflect across against the prosecting arm?—No.

3316. If any current is setting outwards it would act directly opposite to the sea on your outer beam?—Yes.

3317. Which beam sea would be forcing you in shore?—The current would be forcing out and the sea rolling in. I do not think that the current would affect it at all coming out.

3318. You mentioned that leaving the harbour with a north-east entrance with an approaching cyclone, the wind would be from the northward; but would not the direction of the wind depend upon which side of Madras the cyclone was striking?—Yes, it would come sometimes from the north-west; but, as a rule, it is about north-north-east.

3319. And sometimes from the southward?—No; there is not much cyclone from the southward; it would only be partial.

3320. Do they never strike the shore south of Madras?—There you would not have a southerly wind.

3321. Surely you would have an opposite wind if the cyclone struck south, to what you would if the cyclone struck the shore northward?—If you had a south wind you would be to the eastward of the cyclone altogether. The cyclone would be away over the land. When you get the wind round to the south with a cyclone you may consider yourself pretty safe.

3322. Then you never fear a strong southerly wind leaving the harbour?—No, I have heard it spoken of, but I have never seen it.

3323. (*Chairman.*) I do not know whether you are aware that the reconstructed harbour will be 12 feet above the sea level, instead of 6, with wave breakers outside it, and with loose blocks outside, so as to break up the sea?—I have been told that that is the intention.

3324. Do you think that under those circumstances it would ever be safe to ride out a cyclone?—That is a very difficult question to answer what will stand a cyclone.

3325. Would you risk it yourself?—I would not go outside. If I had a wall 12 feet high in the roads supported by a banking outside I would not go out.

3326. (*Sir John Coode.*) Do you think that moorings put down inside the harbour would suffice for you?—Yes, a good mooring inside would hold the ship; but there would be only one tier of ships.

3327. You would not like to be there with two tiers and a cyclone on?—It would not be practicable to have two tiers at any time, because you would not be able to manœuvre to come out when you wanted to.

3328. (*Chairman.*) You think at any rate that it would be safe for harbour craft, such as tugs, dredgers, and so on?—Yes, I think so. It would be just like a dock if this wall stands; but cyclones are so powerful, you do not know what they are going to knock away. I notice the sea never touches the Colombo breakwater at all; it breaks on the backing.

3329. (*Sir John Coode.*) There are no wave-breaking blocks at Colombo.—There is rubble and small stone.

3330. And concrete logs on the top of the rubble.—Yes, I have watched it many times; the sea breaks outside on whatever is outside; it goes up in tremendous columns, and falls on the blocks right away.

3331. (*Chairman.*) Have you ever experienced a cyclone there or thereabouts?—Yes. I have experienced two or three in the bay. I was at sea in one in 1864 in the Bay of Bengal.

3332. (*Sir John Coode.*) Had you any experience of the cyclone of 1872?—No.

3333. I ask you because it is said by many to have been a much heavier cyclone than in 1881, which damaged Madras harbour, and we were anxious to know what was the comparative strength of those two cyclones; but you do not know?—I do not know.

3334. (*Chairman.*) I think I may judge from your former answers, that supposing this entrance to be left where it is now on the eastern face, you would not consider it advisable to narrow it for the sake of reducing the sea in the harbour?—No, the current goes across it sometimes so quick that it would be dangerous.

3335. (*Admiral Sir George Nares.*) The proposal from the Madras Harbour Board is shown on No. 3 plan, which allows for the whole of the rubble portion of the outer north pier being removed. If the outer portion of the north pier were left and the entrance made precisely similar, 400 or 500 feet further in, so as to save the expense of removing the work, would that affect your ship at all?—Would you mind bringing your ship in at that entrance which would be, perhaps, half a fathom less, and bring you nearer to the sea breaking on the shore?—I should prefer to keep the seaward breakwater as far seaward as possible.

3336. On the other hand, you would like to keep the covering breakwater as far seaward as possible?—Yes.

3337. (*Sir John Coode.*) Are you aware that the construction of the work, as shown by Plan No. 3, would involve the removal of a very large portion of the blocks and rubble at very serious cost; do you think it would be worth the large sum of money to do it with; and the considerable delay, because now you will readily understand that the removal of those blocks which have been scattered already, and taking away the rubble on a great portion of the seaward section of the north arm, would involve a very heavy cost; would you still think that that 400 feet would be worth it?—Yes, I would.

3338. Bearing in mind that you have a considerable depth of water under your lee, as you have pointed out to us?—Yes, the further seaward you could have that entrance the better.

3339. Do you think there would be anything like serious danger in the entrance being 400 feet further in, as Sir George Nares pointed out; do you think that if the entrance were further back it would involve less cost and risk; do you think that the risk of making this additional 400 feet nearer would be very serious?—Yes, I think it would be, with a very long arm.

3340. (*Admiral Sir George Nares.*) In bringing you in to the shallower water?—Yes, you would have to bring her so far round to the north to get her straight for the entrance.

3341. (*Sir John Coode.*) Would you not bring her round nearer the outer end of the overlapping arm?—With a ship of 400 or 500 feet, you would have to take a long sweep round.

3342. You would bring her, I suppose, to that side?—Yes.

3343. Will you bear in mind that you have 7½ to 8 fathoms of water under your keel, and plenty of water under your lee?—Yes, I should have plenty of water.

3344. And room enough to bring up if anything did happen, and you were thrown to the leeward?—Yes; the risk would be very greatly diminished by taking them seaward, according to No. 3 Plan, but the cost would be very serious, and it would be a very grave question whether it would be worth the cost at all.

3345. Is there, in your view, any material difference in the risk in the one as compared with the other, or is it only a matter of preference?—With a ship of about 425 feet I would prefer the outermost for navigation purposes. About the expense I cannot say anything.

The witness withdrew.

Mr. CHARLES UNDERDOWN examined.

Mr. C. Underdown.

3346. (*Chairman.*) What appointment do you hold?—Foreman Diver at the Madras Harbour Works.

3347. How long have you been in that position?—Seven years.

3348. In what stage were the harbour works when you first joined?—They were near to completion when I went there.

3349. Have you been employed on the re-construction works at all?—Yes.

3350. Have you been diving yourself?—Yes, I have been down very often.

3351. On the northern pier?—Yes.

3352. So that you have had every opportunity of noticing the current on the north pier during the re-construction?—Yes.

3353. Will you look at that plan before you and show us what current you feel during a north-east or south-west monsoon, beginning with the north-east?—We feel most of it in the south-west monsoon.

3354. Do you feel any in a north-east monsoon?—Very little.

3355. In which direction does it come?—It sometimes comes directly from the south-west, for this reason: there is a large opening at the knuckle of the south pier, and the tide coming from the south goes across the harbour.

3356. (*Sir John Coode.*) You mean at one of the breaches?—Yes, where the tide comes in, which is something as it is now.

3357. (*Chairman.*) At the present time does the north-east current strike into that corner formed by the north pier with the [illegible] I think it does, for the reason that I have seen ever[illegible] ships lying at anchor, and they broke their moorings, and they came and drifted as straight as could be, just about the north-east knuckle of the north pier. It was only about 12 months ago last May there were two came in there, a brig and a barque.

3358. (*Sir John Coode.*) Did they come in there about on the same point?—Within I should say 300 or 400 yards.

3359. Were they lying near together?—Yes, one broke the other adrift. She ran foul of the other and broke the other adrift.

3360. (*Chairman.*) Supposing the harbour to be open in the north-east corner, as represented in the plan No. 1, the current, according to your observation, would sweep right into the mouth?—Yes, right into the harbour.

3361. Supposing that it does go right in to the harbour, it would raise the level of the water there naturally unless it could find some outlet. Can you give the Committee any idea of how it would get out again. You must imagine your harbour re-constructed with the walls double the height of what they were originally, and the eastern entrance closed; what would be the effect at the north-east corner?—There would be more sea in there than with the present entrance during the north-east monsoon.

3362. That is according to plan No. 1; now take plan No. 3; would that change your opinion at all?—It overlaps it more, there would be more shelter with the No. 3 plan.

3363. Would it be less exposed to the action of the current than the other, do you think?—Yes, I should think it would. The strongest current that we have comes from the south.

3364. But does that current coming from the south affect the works on the north side of the harbour in any way?—Only where the breaches are, it lets the current through the breaches.

3365. (*Sir John Coode.*) Are the breaches on the seaward face from the knuckle outwards along that face?—Yes.

3366. Are we to understand that the principal part of the current comes through the first breach at the knuckle?—Yes, what affects the divers most is the sea that comes from the south-east knuckle.

3367. According to this, which is the plan of the works in their present state (*handing a plan to the witness*), it is nearly all breached, but I gather what you mean is this, that the large breach is immediately outside the knuckle of the south pier?—Yes.

3368. (*Chairman.*) During your diving operations are you sensible of a current passing outwards along the south pier?—No.

3369. Not with a south monsoon?—No, not close in where the divers are working; it might be further out.

3370. During how many months in the year can the divers work at the end of the re-construction works of the north pier?—About eight months of the year.

3371. During those eight months of the year is the water still enough to enable them to pick up what is now down there?—Perhaps not the whole of the eight months; it is a more difficult job to pick up than to put down new work; we could not always pick up in the eight months, but we could set the new work.

3372. (*Sir John Coode.*) How many months could you [illegible] I should think not above between 6 and 7 months.

3373. (*Chairman.*) Have you quite made up your mind how you would go to work to pick the concrete blocks up, the wreck of the works as they are submerged?—We should make a pontoon to pick them up by. The pontoon was just made before I left, and I picked one block up and brought it away, and for two months they had to lie up there.

3374. The difficulty, I take it, in that, is not so much in lifting by the pontoon or crane or whatever it may be, but in slinging the block?—We could sling the block.

3375. (*Admiral Sir George Nares.*) Is the water clear enough for you to see it?—Just about, that is all; we can see the block about a foot or 18 inches away from us sometimes, but not always.

3376. (*Sir John Coode.*) With regard to this particular block that you speak of having slung, did it lie by itself?—No, they lay one on the top of the other.

3377. How did you grip it?—We put the grip chain on it.

3378. (*Chairman.*) Taking that as a specimen, how many blocks would you land in a day?—We would not land above two; it is so far to carry them.

3379. How would you get rid of all that work, supposing you wanted to get rid of it, and to make a passage through it?—They have to be lifted on to the rubble base underneath the titan.

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3380. Supposing we begin with plan No. 1: the rains of the old harbour extend across where the proposed mouth is to be, and a great quantity of extra rubble has been thrown there?—Yes.

3381. And some of the blocks have been blown up and dispersed, have they not?—Yes, but only a few.

3382. Supposing that you had to clear away that entrance, and to make a passage 33 feet deep for the passage of ships, how would you go to work?—We should first have to clear the blocks away, and then there is the rubble to pick.

3383. How would you do that; is it possible within any reasonable time?—Yes, it could be done, but it would take a long time to do. We should have to put down staging there.

3384. Supposing instead of putting staging there you were to complete the works right across, so that you could work the titan across it, do you think that that would be an easier operation than by putting the staging across?—I do not quite understand.

3385. *(Sir John Coode.)* Do you think that by re-constructing this work according to the old plan with large blocks on concrete in order to get the titan to the far end portion which has to be removed, and then back-handing your work as you return the titan, you would clear the entrance in that way; do you think that the staging would be a better mode of procedure?—I should think that a staging would be quite as quick and as cheap as the other.

3386. *(Chairman.)* Do you think that the staging would stand the sea?—Yes, we could make staging that would stand the sea.

3387. *(Sir John Coode.)* How are you going to fix the staging?—We do it with a shoe.

3388. You cannot take the rubble blocks from under the staging, you must assume that your staging is clear at the bottom before you can put your walls in, and if it is to be 33 feet your staging must be planted far below?—The staging is to take the blocks away, and you remove your staging to get the rubble away.

3389. How are you to fix your staging with the blocks scattered over the rubble. If the blocks were gone, and the rubble were cleared, it would be simple enough; but if you are to employ staging there to get the blocks away, how is this staging to be fixed, with blocks lying over the surface of the rubble; perhaps you have not considered that?—We do not want the pile above 25 feet.

3390. Then you must have a row of piles of 25 feet, you could not put a single pile straight across there, surely?—We might put in two.

3391. But you would want a tier of piles, with two or three to every 25 feet?—Yes.

3392. Then you must have at least two piles to each 25 feet?—Yes.

3393. And those placed, so to speak, in the middle of the old wreck?—Yes.

3394. Supposing that at the particular point where the 25 feet piles would come, there are three or four blocks lying in the way, what would you do?—We should put down some dynamite, and blow them away.

3395. *(Chairman.)* If one diver can sling two blocks a day, how many divers could you employ, do you think?—It is not what one diver can do, it is the appliances that we have to lift them with. One diver could do more than that, but it is the picking the blocks up which takes the time. We have only got one pontoon at work. Sometimes we can get up a single block in half an hour, and at other times it will take us two hours.

3396. *(Sir John Coode.)* In removing the block that you spoke of just now, did I understand you that you merely lift the block with the pontoon a certain height above the bottom, and then transferred it to the titan?—Yes.

3397. And then the block was lifted to the surface by the titan?—Yes.

3398. Is it transported from where you first grip it with the pontoon, and brought under the titan?—Yes.

3399. How far do you carry it?—To the north end of the north pier.

3400. When you say to the north end of the north pier, do you mean the eastern extremity of the north pier?—Yes, the extreme end of the north pier, underneath the north pier titan.

3401. Would you warp it in?—Yes.

3402. Do you get hold of the block at low water, and allow the tide to lift it, or how do you lift it?—We lift it by a cramp upon the pontoon.

3403. Supposing you had to take a contract for that job, would you proceed in the same way to remove the large blocks under the titan, or do you think it would be an improvement to construct the work temporarily, and then back-hand it as you return, in order to bring the titan to bear upon that portion of the work which would have to be removed. It has been suggested that the best mode of getting rid of and lifting those blocks would be by the temporary construction of concrete blocks which went the entire length of the opening, or of the portion to be removed, and then, having arrived at the extremity as before, to lift the blocks with the titan back-handed, as we call it; would you approve of that?—Yes, I should begin at the outer end, and then back-hand the work as we came back.

3404. Supposing it were decided to adopt the plan according to No. 1, which would be to re-instate practically the whole of the work on the sea front, according to the red colour which you see on this plan, and having arrived at the outer end of the knuckle, then to proceed in a north-easterly direction with this overlapping arm, and the entrance to be formed as you see upon this plan No. 1; would you prefer to re-construct the whole of this work in extension of the south pier from the south pier, or would you prolong the north pier across the entrance, and then run your titan ahead to the southward; bearing in mind that there appears to be a difficulty in backing your titan when you got it to join the sea face of the work and wanted to turn your titan round?—The titan that we have now you can turn round anywhere.

3405. Supposing you had to re-construct the work generally according to plan No. 1, would you work entirely from the south pier with one titan, or would you construct a portion from the south and a portion from the north. What occurs to me just now is, that you could not well adopt that plan, because the large blocks are lying back to the work?—Yes, they are all lying back.

3406. So that you are almost bound to proceed from the north pier, unless you occupy a very long time in constructing the seaward portion of the new work according to plan No. 1 or No. 3. In that case, which would you prefer, to move this work by the titan back-handing as described just now, or would you move it by a pontoon?—I would prefer to remove it by the titan and back-hand the work, for this reason, that we have but very little smooth water there, and the pontoon very often cannot work, and we could work oftener with a titan.

3407. Then I understand that the process would be this: supposing you were in charge of this work, you would proceed with the re-instatement of the south pier up towards the present entrance?—Yes.

3408. And while you were doing that you would temporarily prolong the north pier until you covered the site of the proposed entrance?—Yes.

3409. *(Chairman.)* You say that the state of the water does not admit of using the pontoon very often?—No, it does not.

3410. Would not the same state of the water affect the divers?—Yes.

3411. So that the pontoon and the divers could work together?—Yes, we could work the pontoon and the divers very well.

3412. If the pontoon cannot work, the divers cannot?—Very often the divers can work when the pontoon cannot work.

3413. *(Sir John Coode.)* How many days in the year do you think you could work the pontoon in the way you speak of in slinging the blocks and transporting them?—I can hardly tell you at a moment's notice.

3414. Could you for half the year, do you think?—Yes, I should think for about five to six months.

3415. But would that be five to six months continuously?—No.

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3416. It would be subject to breaks all the year round?—Yes, all the year round.

3417. A break sometimes extends over several days, I suppose?—Yes.

3418. Then do you have several consecutive days during which you could work?—Yes. February is a good month for work, and part of January and March also.

3419. It is only one block, I think, that you have slung?—That was all before I came away.

3420. Were they proceeding to remove the other blocks?—No; they brought the pontoon to the shore again. I did not give them quite lift enough.

3421. Where was this block taken from?—It was near the extremity of the north pier.

3422. *(Chairman.)* Was that done for experiment?—Yes.

3423. Did you pick your block?—No; the diver went down and got the first block he came to.

3424. *(Sir John Coode.)* From what you have seen of the mode in which those blocks have been tumbled about, there would be cases where some of the blocks would be very difficult to sling?—Yes.

3425. You might easily sling one or two blocks, but when you came to a great mass of them lying together, the operation would not be quite so simple?—Precisely.

3426. Did the diver put the sling completely round the block?—Yes, completely round the block.

3427. There was nothing in the shape of a nipper was there?—No, nothing. We have had considerable difficulty at the extremity of the north pier in getting rid of the blocks.

3428. *(Chairman.)* Do you want to get rid of the blocks there?—Yes, in the road of the new work we do.

3429. *(Sir John Coode.)* Is there not the wreck of a titan there?—Yes; but we have taken most of that away.

3430. What were they doing or attempting to do when you came away; was it to move those blocks?—Yes, and clear the ground. We blew it to pieces with dynamite, so that we could lift it.

3431. Is it Mr. Thorowgood's intention to remove them, so as to avoid this awkward curve in the work?—Yes; that has been the point which we have been working for. It is to remove that curve and make it straight.

3432. *(Chairman.)* How many divers have you at work?—When I came away we had 14 in three boats; one at the end of each pier and one at the extremity of the north pier.

3433. Do you go down very much yourself?—Very often; sometimes every day.

3434. What do you consider a day's work for a diver under water?—Four hours. During fine weather it would be unnecessary to lift the blocks with a titan. What we should do would be to sling the blocks with a pontoon and take them on to the outer face of the work and let them form part of the foreshore.

3435. Are you now referring to the pell mell blocks or to the wave breakers?—If there was too much sea we could not get in to do that.

3436. To deal with the whole of the submerged blocks in that way would be a very long operation, I take it, because it would depend upon the weather?—It would be a long operation. The blocks that I was referring to just now were those at the north end of the present entrance.

3437. Near where the wreck of the titan lay?—Yes.

3438. Should you be disposed under any circumstances to take a contract to clear that north-east entrance?—I should not like to take a contract to do it.

3439. *(Sir John Coode.)* Why?—It would be a rather difficult job to estimate either the cost or the time that it would require.

3440. *(Chairman.)* Have you noticed the advance of the sand on the south pier?—Yes; very much.

3441. In how long do you think the present rate of advance will take it out to the south-east knuckle?—These last 12 months it has gained but very little, I think.

3442. *(Sir John Coode.)* You have not taken soundings there off the shore, have you, to know what is going on under water?—No. I judge only by what I can see above water.

3443. Would you be surprised to hear, that according to the soundings which have been taken, the rate of advance below low water during the last three years has been pretty much the same as it had been for the three or four years previously?—I should not have thought it. Of course I have not taken soundings and I cannot judge.

3444. Your judgment is formed solely from what you can see above water?—Yes.

3445. *(Chairman.)* Is there much blown sand comes into the harbour?—No; very little, I think.

3446. *(Sir John Coode.)* Did you notice the surf on the beach between the two piers before the work was damaged?—Yes.

3447. Was it much or little?—Not a very great deal.

3448. Could an ordinary boat frequently land there?—Yes, an ordinary boat could frequently land there.

3449. On the beach itself?—Yes.

3450. *(Admiral Sir George Nares.)* Have you ever seen one land?—Yes.

3451. *(Sir John Coode.)* Have you landed yourself?—No; it is very seldom I land in an ordinary boat; it is more convenient to do it by lighters on the jetty.

3452. We have been told that the surf on this beach and the breakers were so great even before the work was broached that it would be impossible to carry on trade at any jetties projected from the shore; what would you say with regard to that?—For some months in the year we could not.

3453. I am speaking now of the state of things before the damage took place. After the works had been begun, and before the damage took place, were there some months in which you could not have landed there?—There were some months in which you could.

3454. You think that if such jetties are to be carried out to facilitate the conduct of trade more shelter would be required than was given by the work before it was breached?—Yes, if you want to work the whole of the year round.

3455. Do you think that closing the present entrance and making an entrance to the north-east would make the harbour sufficiently quiet to carry on trade from the jetties projected from the shore?—I think so if the south arm goes beyond the north one.

3456. The least amount of over-lap that has been suggested is 500 feet; do you think, that with such an over-lap as that the beach between the piers would be considerably quieter. The idea being to make the harbour so quiet that jetties could be constructed from the shore between the two piers to facilitate the traffic, do you think that an entrance made at the north-east which overlapped about 500 feet would enable you to do it?—I should think that 500 feet would hardly be enough; it would require something more than that.

3457. Have you formed any idea of what would be enough?—500 feet shows very little at the end of the pier.

3458. At any rate you think it should be something more than 500 feet?—Yes.

3459. Of course we leave the difficulties of the entrance to sailors to consider?—Yes, they are better judges of them. In a heavy cyclone, of course, they do not expect to carry on trade in the harbour.

3460. Do you think, from what you have seen, that if these walls were raised, say 12 feet above the sea level, with good wave breakers at the back, vessels could remain there in safety during a cyclone?—They might remain there, supposing there was not too much sea coming in at the entrance. The overlap is to avoid that.

3461. But supposing there were an overlap of say 800 or 1,000 feet, do you think that would do it?—I should think it ought to do it.

3462. Do you think that under those conditions a vessel might remain in safety there during a cyclone?—I know the direction in which the sea comes and what effect it would have; most of it comes north-east.

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3463. Is that the worst sea in there?—Yes, the worst sea.

3464. And your apprehension is that a north-east sea might find its way into the harbour so as to be very inconvenient, to say the least of it, and dangerous, too?—Yes. Only for the sand coming in there I should prefer to see the entrance at the south-east.

3465. (*Chairman.*) Would you prefer now an entrance to the east or to the north-east?—With a good overlap to the north I should prefer it to the north-east.

The witness withdrew.

Adjourned.

At the Board of Trade, Whitehall.

Monday, 8th August 1887.

PRESENT:

VICE-ADMIRAL SIR NOWELL SALMON, V.C., K.C.B., IN THE CHAIR.

SIR JOHN COODE, K.C.M.G.

REAR-ADMIRAL SIR GEORGE S. NARES, K.C.B.

MR. F. C. THOMPSON (India Office), *Secretary.*

MR. FRANK NAPIER THOROWGOOD called in and examined.

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3466. (*Chairman.*) You are, I think, the superintending engineer of the Madras Harbour Works, are you not?—Yes.

3467. Under the Harbour Trust?—Now under the Harbour Trust Board.

3468. Your position is entirely independent of Mr. Parkes, I think?—That is not quite decided yet, I think. It is not decided until I go back again whether I am quite independent of him. That is in abeyance, I think.

3469. As yet, are you carrying out Mr. Parkes' instructions?—Yes, as yet I am; at all events, I was until the work was suddenly stopped by the Harbour Trust Board wanting to raise the question of the entrance. It is from the Government of Madras that I have orders not to go on with the northern pier. I had no orders from Mr. Parkes to stop that; the instructions came from the Government of Madras to stop the work at the northern pier until this question of the entrance is decided. I did not receive that order from Mr. Parkes.

3470. We have your opinions here in different forms on the subject of the reconstruction of the harbour. Have you any quite late data with regard to soundings on the south side and the advance of the sand?—We were trying to take soundings when I left; and I told my assistant who is now in charge to get them whenever he could; and I fancy by this time he has got them, that is to the south of the bend of the southern pier.

3471. Have you formed any opinion as to the length of time it will take for that sand to affect the soundings at the south-east angle to such an extent that navigation there would be closed?—I have never gone into that since the year 1876, when I was first appointed, that is, when I first went out there. I went into it then very thoroughly with Mr. Parkes. Then, I think, we reckoned, from 15 months' observations, that it would take 81 years for the four-fathom line to advance to the bend of the south pier; that is then. I have never myself made a calculation since, but I have had my eye on the annual advance and retreat. It advances and retreats according to the south-west monsoon.

3472. Are you aware of the calculations that have been put before this Committee in that respect?—Only 10 minutes ago.

3473. Did they take you by surprise at all?—Well, the calculations take me by surprise. I have not been able to go into them, but they take me very much by surprise.

3474. But as you have not examined into the question personally since 1876, you cannot give us any opinion as to the correctness of those sections or otherwise?—No, I cannot, for I have not seen them long enough for that; but I may say I have never had, and no one in Madras ever has, any apprehension about the rate of advance of the shore on the south side. It is gradually diminishing. The high-water line advances at a gradually decreasing rate.

3475. In view of that advance, are you prepared to admit that before very long the sand will enter the harbour, supposing the entrance to be kept on the east face?—I should think it would be some 80 years before that will happen; the work has been going on ever since 1876. There is no shoaling at the tangent point of the curve of the south pier yet, where the curve begins. Then there is a very deep portion of the sea beyond the tangent point of the curve out to the entrance.

3476. We have had evidence of a certain deposit of sand at that knuckle?—Yes, there is that this particular year, and I think that is simply the local result of having a cyclone in May, which we have not had for nine years, which always alters the bottom. There has not been a cyclone in May since 1877. There is no doubt in my mind that that did make some local disturbances which are different from what we have had before.

3477. Then you would not consider the advance of sand as affecting the question of the eastern entrance?—I should not at all.

3478. (*Admiral Sir George Nares.*) Have you plotted the advance of the four-fathom line yourself, and compared it?—Up to our survey of last September I have, but not since then.

3479. You are thoroughly acquainted with the advance of the four-fathom line up to last September?—Yes.

3480. But, calculating on that, you would not suppose that it would take 80 years for the four-fathom line to reach the knuckle, would you?—I have not calculated for the knuckle from the 1877 sounding. I have not made any actual calculation since 1876.

3481. (*Sir John Coode.*) If I rightly understood an answer you gave to a question of the Chairman just now, you judge of the rates of advance by what you see on the shore rather than from the soundings. You spoke of the advance and retreat of the shore?—The high-water line more particularly.

3482. Yes?—That is what I have gone by more particularly since the question first arose when the work first began. I have not gone very deeply into that, but I have watched the advance of the high-water line regularly.

3483. You have seen the tabular statement, I suppose, prepared by the Committee?—I have only just seen it.

3484. Should you like a little more time to look at it?—I have not had it in my hand.

3485. What did you make the advance of the four-fathom line to be when you tested it last; do you recollect?—I cannot recollect from memory. The different charts would show. I could not say from memory what it was. I should have to refer to the different surveys.

3486. However, we understand from Mr. Parkes that he agrees with us as regards the rate of advance from the two-fathom line downwards; he has seen the tabular statement that we have prepared, and he has stated to us pretty clearly that he agrees below the two-fathom line with us; but his views are that we

ought to take further into account the changes that have taken place between the two-fathom line and the high-water line. Supposing a high cyclone were to occur, what do you think would be the nature of the change it would be likely to bring about?—In May the waves and current, whatever current there is, comes from the south. A cyclone will stop that, and for a day make the current first from the north and then still water. That would stop for a period of some 24 or 36 hours the travel of sand from south to north, and might cause a deposit anywhere about the harbour or outside the harbour by suddenly checking the movement.

3487. (*Admiral Sir George Nares.*) By causing still water?—By causing still water. In the cyclones we have in the month of November the current does not change, because nearly always the strongest force of the sea comes from the north of east; then the prevailing wind is north-east.

3488. (*Sir John Coode.*) You referred just now to the absence of any sand at the knuckle of the south pier?—No shoaling, I think I said.

3489. Just so,—no shoaling?—Unless it is what I consider this recent shoaling that the last survey showed after the storm of May.

3490. We have no distinct evidence before us in the way of soundings or depth to show that there has been any shoaling near the knuckle of the south pier. We have been told that a shoal has grown up, or is growing up, just outside the knuckle of the south pier; is that the one which you speak of?—That is what I consider the local effect of the cyclone.

3491. Have you or have you not discovered any actual shoaling there?—There is a little shoaling on this last survey.

3492. To about what extent?—About two feet.

3493. Does that extend over any large area?—I cannot remember that without looking at the chart.

3494. Can you give any rough idea?—That is the most recent one (*pointing to a plan*).

3495. At about what point would this loss of two feet be?—It is about in there (*pointing to a chart*).

3496. Lying to the south-east of the knuckle?—To the south-east.

3497. At about what distance?—That is a former sounding, and this is the present one. The seven-fathoms has come out to there—that is the shoaling.

3498. Then it is not, as has been described to us before, in the nature of a patch?—I do not know how it was described.

3499. It was described to us as in the nature of a patch, and was marked as of elliptical shape just off the knuckle of the south pier?—I do not know where that came from.

3500. It was not shown on a plan; it was described to us in general terms by Captain Taylor, I think?—That comes out plotted about two feet. That was the seven-fathom line, and there is the seven-fathom line (*pointing to the plan*).

3501. Then what you speak of is a general advance?—Yes, a general advance.

3502. Nothing in the nature of a patch or isolated shoal?—It is a general advance in that particular place. That is, the only evidence I have. Those are my own soundings both of them, of both dates. I did not know it had been described as a patch.

3503. Captain Taylor said he judged of it by the discoloured water?—You cannot judge of it in that way; discoloured water will spring up in two hours on that coast.

3504. (*Chairman.*) I take it you have had a better opportunity of weighing the pros and cons of this question of the change of entrance than any one. Are you prepared to give your opinion whether you would adhere to the old plan on which the harbour is now being reconstructed, or whether you would make such a change as is desired by the Trust Board—closing the eastern entrance and opening one to the north-east?—On considering the whole question for a long time I should be for adhering to the eastern entrance.

3505. Have you considered at all the feasibility of covering that eastern entrance with a breakwater at a sufficient distance from it, and at the same time to protect the harbour from the sea that enters at that entrance, and to give ships room to manœuvre inside?—I have never considered it at all seriously. I have simply thought of it, but I never considered it seriously in any way.

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3506. Captain Taylor, in giving evidence, has given it as his opinion that it is impracticable, for the reason that you have no fixed platform to work from?—I think that might be got over. That does not prevent its being made, I think. It would be an increased difficulty.

3507. Up to a certain point, perhaps?—Yes.

3508. But would not the breakwater become a very dangerous shoal, and would not there be very few days in the year on which you could work upon it, as soon as it got within a certain distance of the surface of the water?—Yes, I think it would. It would be very dangerous indeed. It is very seldom smooth at Madras. There is very seldom smooth water weather—there is always the ground swell.

3509. What I mean is, that when they come to place the fixed work upon such a bank as that from boats, as compared with the end of the jetty already run out, the great difficulty would commence, would it not?—I think it would.

3510. And there would be but few days in the year on which a boat could lay a stone?—Yes, I should think very few days.

3511. Are you prepared to condemn that idea for that reason?—I should not condemn it entirely for that reason. I do not like the idea partly for that reason, and partly because I think it would be quite possible that a spit of sand might form inside it. I do not quite know what distance the breakwater is supposed to be to the eastward of the present entrance, but to make it navigable for ships it ought to be a good long way off, and then, of course, the farther it is away the longer the breakwater would have to be.

3512. That, of course, would have to be governed by the direction of the sea, and the south and north-east monsoons?—Yes.

3513. Supposing either of those plans to be adopted, to which do you give the preference?—I think it lies between those two, and of those two I prefer No. 3.

3514. In spite of the fact that it would be necessary to pick up so much more of the old work?—Yes, in spite of that.

3515. I see that in the estimates you have made with regard to these two, you estimate the cost of No. 3 at four lacs less than No. 1, although you have so much more work to pick up?—I did not remember that, but if that is so, that is all right. I have taken out the quantities roughly.

3516. (*Sir John Coode.*) Four-and-a-half lacs, in fact, practically (*placing the figures before the witness*)?—Yes, there is a greater length to be built there. There is a considerable difference, I think, in length between the two. What we have been building the last year-and-a-half would all have to come up. I reckon it would come to about four lacs to remove that.

3517. Do you think that you could pick up the old work as readily from boats of any description as you can from the built work on the titan?—No; I have not the smallest doubt about that.

3518. Then you think it would be better to complete that work, closing that entrance first, and then reopening it for the sake of the advantage afforded by the use of the titan?—That is my view.

3519. (*Admiral Sir George Nares.*) Closing the north-east one?—Yes.

3520. (*Chairman.*) In the case of No. 3 you would not be able to get the titan to work to pick up the old work at all?—No, you would have to do that by some sort of dredging apparatus, or by blasting and dredging.

3521. To pick up this piece of work, the end of the north arm on No. 1 plan in the new design?—To remove the work on the No. 1 plan is to remove a very much heavier section of work than anything that remains in the line of old ruins. The work that would have to be removed from No. 1 plan consists of bonded work. The blocks are bonded together and dowelled together, and protected further by 30-ton blocks put as "pierres perdues" on the sea side, and running out to a bottom width of 60 feet. They would

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all have to be pulled up, which would be a most serious matter, because they are so far off from the work.

3522. (*Sir John Coode.*) How far from the titan or rather, how far from the work could you deposit the wave-breaker blocks?—37 feet from the face of the wall.

3523. Not more?—No; to the centre of the block, 39 feet.

3524. Then, supposing it to be decided to adopt a plan somewhat of the nature of No. 1, and that it should be desired to increase the width of the wave-breaker in order to reduce the re-entering angle as much as possible, how would you proceed to get those wave-breaker blocks further up?—With our existing plant?

3525. With your existing plant?—You can make them roll down by a little manipulation. You can roll them out to any length, but it is rather hazardous work. The corners might break off, but it would be possible to do that, no doubt.

3526. Supposing it was decided to do it, would you recommend that special plant should be provided for the purpose, or would you rather proceed with the plant you have now available?—Taking that as a rough representation (*pointing to the plan*)?

3527. Yes?—What does that scale (about 200 feet, I suppose) from the walls?

3528. About 130 at the outside; 100 feet you may say?—With 100 feet I would do it with the existing plant.

3529. Would you do it with jacks after having dropped the block?—No, I would let the slope run down.

3530. I suppose these several estimates, which are contained in your report of the 2nd May 1887, have all been gone into in considerable detail?—Not very greatly.

3531. At any rate in sufficient detail to satisfy you that the sums are approximately accurate?—Yes. I only had two days to get them made in.

3532. Have you formed any idea of the time that would be necessary to construct the work according to No. 1 plan?—No; I do not think I have on that design. That was gone into in 1883, and referred to the Committee of Sir John Hawkshaw.

3533. Was the time mentioned then?—That I do not remember. I never went into that again. I just took the estimate of that date and applied it to No. 1 design. I should think the time would be about three years.

3534. To complete the whole, do you think?—Yes.

3535. I take it those estimates were based upon your latest experience up to the time they were framed?—Yes. The cost of pulling down I had no alternative but to guess at.

3536. That we quite understand, considering it to be a somewhat doubtful item?—An unknown quantity.

3537. (*Admiral Sir George Nares.*) That is the removal of the present wrecked work?—Yes.

3538. (*Sir John Coode.*) And you have an abundant supply of stone, I suppose?—Yes.

3539. There is no reason why any of the new work should cost anything more than the work already executed, is there?—No, there is no reason why it should cost more than the last year's work; since the work was originally made the South Indian Company doubled their charge for haulage. However, those rates are based upon that increased price of haulage, so there is no reason to suppose that future stone would cost any more than the stone of the last year.

3540. The south arm is now advancing, is it not, towards the north-east?—Yes, I should think it is about *there*; that is nearly to the outer tangent of the curve.

3541. And at about what rate per annum is that proceeding?—That is proceeding very slowly, I am sorry to say; about 400 feet.

3542. That is much less than the rate on the straight course, of course?—Yes.

3543. Why is that so?—Because *here* there are pieces of the original pier broken, isolated rocks, and the swell coming from the south makes very great confusion over the tops of those rocks, and pours down in a cascade just where the divers are working, spins them round, and interferes with their work most terribly. When we get further away on to the straight portion I do not think that will happen at all.

3544. Generally that answer is of the nature I expected; that is to say, there are considerable difficulties in dealing with the wrecked portion of the work?—Yes.

3545. I gather from what you have just told us that those difficulties are greater now at the curve than you expect they will be further on on the straight portion?—Yes.

3546. Still you will never get rid of them altogether?—Not altogether; but we get further away from the old work as we get further out. We have not got to the full width yet.

3547. You are now passing off from the old work on to the new?—Yes.

3548. But still, even so, there will be much greater difficulty in getting your foundation in alongside that wrecked portion of the work than in the work on the straight arm?—There is not the least doubt of it. I can see that clearly; but my reason for saying we shall be able to go on better there soon is simply gathered from my experience here—as we have left the ruin on the left hand side of the north pier the work has been easier to complete.

3549. While you are passing from the old line to the new; that I quite understand?—Yes.

3550. Shortly you will be to a great extent inside the old work?—Yes.

3551. Is there any reason to apprehend that you will find some of the blocks distributed over the rubble bank?—I have had them all cleared away.

3552. The full length is cleared?—Yes; where the new foundation comes in.

3553. How were those stones removed?—We blew them up with dynamite, and smashed them up into pieces big enough for rubble.

3554. So as to form an integral part of the mound?—Yes.

3555. In one of the plans put before us by Mr. Parkes there was rather an awkward horn at the northern side of the present entrance, which we understood was caused by the ruins of the old titan?—A little crook in the line?

3556. Yes, an awkward crook?—*Yes*, I want to get out of that in actual practice. I am trying to clear it away.

3557. I am glad to hear you say that you think you will get rid of the wreck of the titan; you think you will be able to do it?—I have got nearly all the Titan up.

3558. There will then be no longer any necessity for that crook in the work?—I think not. I think I shall be able to do it quite straight.

3559. (*Admiral Sir George Nares.*) You prefer the eastern entrance to the north-eastern entrance, I believe?—Yes, now, as things are at present.

3560. With an eastern entrance will there be quietude inside the harbour during the cyclone?—There will not be absolute quiet, there is no doubt.

3561. Will there be sufficient quietness to prevent the craft that are used for loading and unloading being wrecked?—I think there is no doubt there will be sufficient quietness to prevent that.

3562. Were you present when the cyclone which destroyed the eastern face of the harbour took place?—Yes.

3563. And you saw the sea on that occasion?—Yes.

3564. Do you think when the improved harbour is completed, and the entrance narrowed, that it will be quiet enough inside the harbour to prevent the casualties that occurred on the last occasion?—Yes, I do; and I base that opinion on what occurred on the last occasion. Till the two breakwaters gave way the water was very fairly smooth indeed, and a man could go out in an ordinary boat—not in a surf boat. Three of my men went out on to two little steamers that were anchored in the harbour each day when the storm was at its height before the work gave way.

3565. Then the cargo boats were not wrecked until after the walls gave way?—I cannot say from memory about that. My impression is they were not.

3566. We have it in evidence that, except for the steam hopper barges, two of which were lashed together, and rode out for a considerable time, all the harbour craft were destroyed before the walls were destroyed, and the two hopper barges were destroyed afterwards?—They were destroyed a long time afterwards—about six in the evening. I could not say actually from memory about the cargo boats in the early morning, because the south pier was breached by seven o'clock in the morning, and I do not know what evidence there is that the cargo boats were wrecked before the piers were breached. It is certain that four or six of my men went out in an ordinary rowing boat on to the hopper barges at six in the morning without inconvenience in an ordinary open boat.

3567. When the seas produced by the cyclone were at their height?—Yes; I should think they were at their height.

3568. But we are told that the seas on that occasion struck the screw pile pier, and destroyed the end of it, which is 18 feet above high-water level. Allowing two feet for the rise of the sea, that would give 16 feet for the height of the cyclonic wave that damaged the end of the pier. Shall we have anything approaching such a sea as that in the harbour when the works are completed?—I do not think so. I do not think there is any chance of it with the present design, the raised walls, and the narrowed entrance. A great deal of that confused sea on that occasion inside the harbour was caused by the immense amount of water that came over the walls, and filled up and made a pond of a higher level than the sea outside. It tried to rush out through the entrance, was met again by the waves coming in, and that created the most confused sea that I ever saw inside.

3569. (*Sir John Coode.*) That is in the nature of a basin filled to the brim, as I understand?—Yes.

3570. You think that will not happen again?—I do not think it will with the wider and higher walls.

3571. (*Admiral Sir George Nares.*) At all events, not to the same extent?—No.

3572. As to the expense of the No. 1 and the No. 3 plans, No. 1 being upwards of four lacs in excess of No. 3, is the additional expense in consequence of the increased breadth of the wave breaker that would have to be provided at the re-entering angle?—No.

3573. The actual length of work is much the same?—No, it is not. It is in consequence of the more costly operation of removing what has recently been built at the north pier.

3574. You say that you cannot well guess the expense of removing the under-water part of the north-eastern face, which would have to be removed in case No. 3 plan was carried out, but you have been able to calculate much closer the cost of removing the above-water work,—that No. 1 plan?—Hardly so. I had no actual data to go upon for either. I had no doubt in my own mind that to remove the new work that has been built would be much more costly than to remove what is, in fact, partially removed under water now; and I put down the cost required to remove the new work that has been built at a higher rate than any other work that we have done in the way of removing, but I did not really have any good data for either of them.

3575. With No. 3 plan, how do you propose to remove the below-water work and open the north-eastern entrance?—In the short notice I had for preparing these alternative designs, I was thinking of using Priestman's dredgers with claws—the claw dredgers.

3576. From boats?—From floating craft. I was thinking of using them.

3577. And could you employ floating craft there before the eastern entrance was closed?—Yes, you could employ them.

3578. Then, in fact, floating craft with dredgers could be employed with both the north-east entrance and the eastern entrance open?—Yes, they could.

3579. It would be necessary to employ these dredgers with both the north-east and the eastern entrance open, if they were used at all?—Yes, it would.

3580. Could you employ them in that way for any length of time in the year?—That is a very hard thing to say. I should say no, not very many days in the year, I think—not so near ruined work.

3581. Then the actual plan of operation of opening a north-eastern entrance has still to be closely considered?—Yes, every detail of it has to be.

3582. (*Sir John Coode.*) What is the greatest weight that you would propose to lift by the Priestman crane?—About three tons, I think.

3583. Then you would not attempt any of the larger blocks, of course?—No, not with the Priestman crane. I should sling them with slings. I have made a pontoon out there which has picked up 17 and 27 ton blocks already.

3584. You have taken up blocks of 17 tons?—And 27 tons—some of the old superstructure blocks—just before I came away.

3585. With a crane of that class?—No, with a floating pontoon with a 15-ton crab in the middle, the chains going down.

3586. How do you grip the blocks of that class by the sling?—By means of an inch-and-a-quarter stud chain put round them.

3587. By means of a diver?—Yes, it answered very well indeed.

3588. Did it answer so satisfactorily that you think you will resort to that in future. Why do you prefer the Priestman crane?—To get the rubble up.

3589. A Priestman for the rubble?—Yes.

3590. But not for the larger blocks?—No.

3591. And I suppose it would be a question, in the case of some of the larger blocks, whether you would not use dynamite and scatter them?—Yes, of course.

3592. Of course, in matters of that kind, you would be governed by circumstances?—Yes, entirely.

3593. Did or did not the various estimates which were given on the 2nd May 1887 refer to the expenditure as from that date?—I cannot quite remember whether they did or not.

3594. Do you think you would remember if you were to see your report?—I think it was as from that date.

3595. You sent a description on the 2nd May. Perhaps if you refer to that you may refresh your memory, because it is well to know when that cost would date from (*handing a document to the witness*)?—Yes, it is from the date. I see I have put here, "Roughly speaking, the cost of this scheme now that the "entrance is nearly closed." I have allowed for what was done at that date.

3596. Then those estimates were for the expenditure from the 2nd May 1887?—Yes.

3597. You told us, I think, that to complete the work according, or generally according, to plan No. 1, would occupy three years from this time?—About three years at the very least as a minimum.

3598. As a minimum?—Yes.

3599. And how long would No. 3 require?—I do not know that I should be right in expressing myself about that, but I should think a little less than three years.

3600. (*Admiral Sir George Nares.*) Have you any information about the quantity of sand held in suspension in the water with the different monsoons?—No, I have not any information. I have tried to get it over and over again, but that sand in suspension is a perfect puzzle to me. I have been out surveying at six o'clock in the morning, and in depths of two fathoms south of the harbour you can see every sand mark on the bottom, every ripple mark.

3601. The water is so clear?—The water is so clear.

3602. At seven o'clock (in an hour's time) the water has been perfectly thick right out to eight fathoms, and on lowering a bucket over the boat's side and taking up a bucket full of the water and letting it stand, there is about a thirty-second of an inch of sand all over the bottom of the bucket.

3603. (*Sir John Coode.*) With no difference in the wind on the beach in the interval?—Only a ripple. The water would be perfectly smooth for surveying still.

3604. (*Admiral Sir George Nares.*) Would this be with both the north and the south monsoon?—Both north and south.

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3605. Then the water is considerably laden with sand whenever there is a breeze?—No, I could not say that. It is not so simple as that. It sometimes is and sometimes is not, and I cannot make out in the least what it is that governs it.

3606. (*Sir John Coode.*) Does that sand appear to have come off the beach, or been disturbed from the bottom, or what?—It seems to me to have come off the beach and worked outwards.

3607. That is what one would expect naturally?—That is what seems to me to be the case.

3608. Did the breeze cause any material disturbance on the beach?—No, nothing serious. There is always a surf, but it caused nothing noticeable.

3609. (*Admiral Sir George Nares.*) With the northerly monsoon is the water always discoloured for a considerable distance outside the harbour?—No, not always; sometimes it is. This I can say positively, the discolouring is much more conspicuous with the south-west monsoon than with the north-east monsoon. There is no doubt about that. That I can speak positively about.

3610. (*Sir John Coode.*) That is to say, the discoloration is always greater?—And more continuous.

3611. And longer continued?—Yes.

3612. During the south-west monsoon how many days would you say that discoloration would appear?—I should say somewhere about 40 days; not on consecutive days, but on 40 occasions.

3613. And during the north-east monsoon?—Perhaps a dozen; 12 days.

3614. (*Admiral Sir George Nares.*) Can you give us any information about the northerly current produced by the north-east monsoon as to its effect against the north pier of the harbour?—Yes, I can give you some information about that. In the north-east monsoon, if the wind has been blowing fresh for a week, there is considerable current from the north. If the wind has been very light, the current is less; I have never measured more than three miles an hour; that is the maximum. This being the north pier (*pointing to the plan*), in the north-east monsoon there is a set of current outwards parallel to the north pier, so that if a float is put to the north of the harbour, opposite the Sailors' Home——

3615. How far from the shore?—Say about the four fathom line.

3616. (*Chairman.*) It must be outside the surf, of course?—Yes.

3617. (*Sir John Coode.*) Opposite the four-fathom line, opposite the sailor's home, that is clear so far?—It will approach the north pier, and then, I cannot say at what distance, it would begin to go outward to within about 200 feet, and then take an easterly direction.

3618. (*Chairman.*) And then?—Then south again.

3619. (*Sir John Coode.*) And where were your measurements for the velocity taken?—On a line parallel to the shore or parallel to the breakwater?—Parallel to the shore; I have taken the velocity out here before the work has advanced far.

3620. The velocities you spoke of just now as having measured on the four-fathom line, opposite the sailor's home, and running towards the breakwater, were taken on that line, that is on the north and south?—No, not the velocity. This is only an observation I have made of the direction of the current. The only velocities we have ever taken were outside there.

3621. Can you give us any idea of the velocity which you spoke of as setting along the back of the north pier?—It is very slow.

3622. I think Captain Taylor denied the existence of any. The pilot was positive that there was a current?—Captain Taylor probably never tried. I cannot tell you the velocity; it would be very slow.

3623. (*Admiral Sir George Nares.*) If No. 3 plan were carried out, do you think that the easterly set along the north pier, or outside the north pier, would set vessels entering the north-east entrance against the covering arm of the breakwater outside?—No, I do not think so.

3624. It would not be sufficiently strong to do so?—No, I do not think so; oh, no.

3625. Or do you think there would be any exceptional deposit of sand to block up that north-east entrance?—No; I think there is not the slightest fear of that. There has no deposit of sand occurred here at all since the work began—"here" being the north of the harbour.

3626. (*Chairman.*) Have you ever landed in an ordinary boat on the beach inside the harbour?—I do not think I ever have; I have always got off at one of the breakwaters.

3627. Is it ever possible to land on the beach inside the harbour in an ordinary boat?—With the piers in their present state?

3628. Yes?—Oh, yes, it is quite possible.

3629. (*Sir John Coode.*) Often?—I should think throughout the month of February almost every day.

3630. Take it over the whole year?—No, not often.

3631. Can boats land every day at the outer end of the present jetty?—No, not every day; not in a storm in November, the waves strike the planking.

3632. Would they be able to land there 300 days out of the year?—Yes; I should think so, perfectly certain.

3633. At the outer end?—Yes; February and March are the two finest months.

3634. (*Chairman.*) I want to ask you a question about the groynes that have been constructed from time to time for the protection of the coast line. You are familiar with the circumstances?—I am familiar with them up to the north of the harbour but not to the south. To the north of the harbour there was a great encroachment of the sea.

3635. That is in consequence of the harbour works?—Yes; I tried to stop that at first by throwing out groynes, so I know all about the ones to the north of the harbour; but the south of the harbour I have had nothing to do with, because the sand buried them all up there.

3636. That is just what I was going to ask you; do you know any of the details of those groynes; do you know about the length of the longest of them?—I cannot tell you from memory. I have them at Madras. At Madras I have old plans of them got out at Fort St. George.

3637. Has the sand ever stopped short of entirely burying them?—I do not know whether it has.

3638. What I mean is this; just comparing one of those groynes with the south side of the harbour, we anticipate that the sand will reach out as far as the harbour works go?—Yes.

3639. The contention of some of the witnesses is that the sand will not advance very much further than it is now. Are you aware of any groyne existing to the south of the harbour of Madras, where the sand has stopped short of the extent of the groyne?—No, I am not; but then, you see, all the time that I have been at Madras the harbour has been under construction, so that the south pier has practically been a huge groyne which has stopped the sand.

3640. I am looking at it from that point of view?—The sand has buried the groynes further south. They have been buried here, but they would not have been buried so soon, of course, but for the harbour works themselves. I have never had an opportunity of seeing the coast without the harbour works; that is what I mean.

3641. The harbour works have affected the groynes right along?—The harbour works have stopped such an immense lot of sand that it has buried the other groynes.

3642. Then we will go on with what prompted my question. General Sankey sees no difficulty in arresting the sand to the southward of the harbour works by means of groynes. Do you agree with him?—Yes, I agree with him. There would be no difficulty in that.

3643. Is that in accordance, do you think, with your experience?—It must be a very long groyne.

3644. Longer than the harbour?—Yes, it is no good putting out short groynes.

The witness withdrew.

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MR. WILLIAM PARKES, M.Inst.C.E., recalled; further examined.

3645. (*Chairman.*) I think I may say that we see no reason to modify the result of our calculations as to the advance of the sand, unless you think you can put anything before us that will enable us to do so?—Well, I hardly know what your conclusion is.

3646. The conclusion is roughly that according to the present advance of sand the four-fathom line will have advanced as far as the knuckle of the south arm within 20 years?—That being based upon a comparison of the advance of the two, three, and four fathom lines for the three years preceding 1882 and the four years succeeding 1882.

3647. Being based upon the soundings, as a matter of fact.—Those were the dates of the soundings, 1879, 1882, and 1886. I am bound to say that is a conclusion in which I cannot agree. I can hardly tell what facts you have taken into account in coming to that conclusion.

3648. Absolutely nothing but the soundings.—Absolutely nothing but the soundings. Then my conclusion is, that if with the soundings you combine the changes that have taken place in the levels which are not got by soundings, but which are got by observation, you get a very different result. Of course you have seen the table that I handed in.

3649. Quite so; I quite realise the difference between your view and ours?—You remember that my conclusion is not based at all upon that table. It was come to, I may say, before this last survey was made, and with regard to that survey, all I say is, that it simply confirms my conclusion. My conclusion was formed independently of that, and I can find nothing in that in any way militates against it. It is exceptional, but it is an exception that I have been looking forward to any time these last 10 years, and it is nothing more than what I have expected every year. I am perfectly satisfied from that that there is not the slightest ground for believing that during, or at any time previous to, the year 1886 was there anything to encourage the idea of the rate of advance being accelerated by anything previous to that survey; but to my mind it completely bears out the conclusion which I had previously formed, that the advance is proceeding in a diminishing ratio; and when I compare the amount of accumulation that has taken place from the commencement of the works, with the space that will have to be filled before the four-fathom line passes the corner of the pier, I find that the time requisite for filling that is somewhere about 50 years from the present time. Now I should be very glad,—as you have said that you have formed a different conclusion from that,—to put on record some few of the facts on which that opinion is based; and I may say that it is based upon an accumulation of facts which have come before me for the last 10 years, and up to the present time I have found nothing in the slightest degree inconsistent with that conclusion. Before we go into the facts it is, perhaps, desirable that I should just mention one or two general principles that I believe are universally accepted, because it is to those principles that we have to apply the facts. The first is this: I believe it is generally acknowledged that where a light sea,—that is, a very moderate sea,—impinges upon a sandy shore obliquely, it drives the sand before it quite independently of any current. What the amount of drift in that way is, depends upon various circumstances, but it is essentially a fine-weather action—not absolutely calm, but with such an amount of sea as there is almost always at Madras. It is an action which takes place to the greatest extent between wind and water; just a belt over which each breaking wave washes up the shore, and washes down again. Every wave transports a certain amount of sand a few feet to leeward, at and near the water level, but the action very rapidly diminishes as you get into the greater depths. Now, assuming that *this* shore lies north and south, a south-east sea would naturally have the effect of driving the sand to the northward. A north-east sea would have the effect of driving the sand to the southward. I do not mention it as a fact, but I mention it as a principle, which is established by universal experience, and one that we may look for as likely to occur at Madras. *That* is with regard to very moderate seas. When we come to heavier seas we get a different result. These heavier seas are deflected into a line, in which the ridge of the wave is more parallel with the shore. They fall upon the shore consequently more parallel. There is less of the oblique action, and there is less of the lateral movement of the sand, but the effect of those heavier seas is sometimes to draw down the sand from the upper level towards the lower, and sometimes, under certain circumstances, but more seldom, the effect is to drive it up from the lower—the greater depths—up to the surface; so that sometimes from these seas you get an apparent accumulation; at other times you get an apparent erosion. Now that accounts for a fact of which we have some experience at Madras, especially with the north-east seas north of the harbour, if we have light north-east seas, such as come during the time of fine weather, in the north-east monsoon, we get an accumulation on the north side of our groins, or other obstacles. That, I should say, appears as an accumulation, as a growth of the high-water line outwards.

3650. I think, if you will excuse me interrupting you there, that is contrary to the evidence?—I beg your pardon; it is perfectly in accordance with the evidence. Here it is; every year we have watched the eating away on the north side of the harbour from year to year.

3651. Not an accumulation?—Not an accumulation immediately there, because it does not reach that. We have cut off the possibility of its showing as a sandy beach from a point about a mile north of the harbour, but beyond that, where we have an obstruction, or rather an indentation, the end of which is an obstruction, we have a constant erosion from year to year, and that annual erosion is the balance of an accumulation from September to March, and an erosion from March to September. Now, during the time that the north-east monsoon is blowing, and it has been observed to me time to time watched, and it has been observed to me by the staff out there that while the moderate monsoon seas are acting on the shore obliquely, there is an accumulation. If the sea gets heavier with the wind in the same quarter, still north-east, and still a north-east sea out in the offing, that north-east sea rakes down the sand from the upper level, and makes an apparent erosion, so that it is proved beyond all doubt that a moderate north-east sea produces an accumulation north of the harbour during the north-east monsoon; a stronger sea produces an apparent erosion. The erosion produced by the heavy north-east sea is merely temporary. It is washed up again in course of time, and the total effect at the end of the year is that there is a little more erosion than there was in September of the previous year. Now that applies to the north coast of the harbour only, and I mention it because it has been frequently observed there that there is this apparently different action of the light seas and heavy seas; but on the south of the harbour we have precisely an opposite effect, so far as the accumulation is concerned. *There* we have not an annual erosion, but an annual accumulation, and, until last year, we never had any exception to that. The curious thing, to my mind, is that it should have gone on for 10 years without showing any exceptional result; but, for the first time last year, we did get one of these heavier seas, during the season in which accumulation is generally going on, which had the effect of drawing the sand down from the land, and depositing it at two and three fathoms. It does not appear to have gone much beyond four fathoms, so far as we can judge, but it has drawn it down from the top and deposited it between the two and the four fathom lines. Now, the fact that weighs very strongly upon my mind is that this annual advance is so very regular.

3652. (*Sir John Coode.*) Advance of what?—Of the shore line to the south of the harbour.

3653. (*Chairman.*) The high-water line?—The high-water line. It begins with some considerable width and with very slight irregularities. It goes on getting narrower and narrower up to March 1886. Now, in May 1886, there comes a heavy cyclone sea, the first that we have had in the month of May. We have had them in November, but we have never before had them in May. I confess I have some ideas upon the subject, although I cannot put them forward as facts, as to why the May cyclone should act differently from the November cyclone. The November cyclone does rake down the sand to a certain extent, but it appears to be more quickly recovered. The effect, however, of this May cyclone was to cause a very considerable erosion in the shore line, and so great that it was not recovered even by the following March, so that the March line

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3620. The velocities you spoke of just now as having measured on the four-fathom line, opposite the sailor's home, and running towards the breakwater, were taken on that line, that is on the north and south?—No, not the velocity. This is only an observation I have made of the direction of the current. The only velocities we have ever taken were outside there.

3621. Can you give us any idea of the velocity which you spoke of as setting along the back of the north pier?—It is very slow.

3622. I think Captain Taylor denied the existence of any. The pilot was positive that there was a current?—Captain Taylor probably never tried. I cannot tell you the velocity; it would be very slow.

3623. (*Admiral Sir George Nares.*) If No. 3 plan were carried out, do you think that the easterly set along the north pier, or outside the north pier, would set vessels entering the north-east entrance against the covering arm of the breakwater outside?—No, I do not think so.

3624. It would not be sufficiently strong to do so?—No, I do not think so; oh, no.

3625. Or do you think there would be any exceptional deposit of sand to block up that north-east entrance?—No; I think there is not the slightest fear of that. There has no deposit of sand occurred here at all since the work began—"here" being the north of the harbour.

3626. (*Chairman.*) Have you ever landed in an ordinary boat on the beach inside the harbour?—I do not think I ever have; I have always got off at one of the breakwaters.

3627. Is it ever possible to land on the beach inside the harbour in an ordinary boat?—With the piers in their present state?

3628. Yes?—Oh, yes, it is quite possible.

3629. (*Sir John Coode.*) Often?—I should think throughout the month of February almost every day.

3630. Take it over the whole year?—No, not often.

3631. Can boats land every day at the outer end of the present jetty?—No, not every day; not in a storm in November, the waves strike the planking.

3632. Would they be able to land there 300 days out of the year?—Yes; I should think so, perfectly certain.

3633. At the outer end?—Yes; February and March are the two finest months.

3634. (*Chairman.*) I want to ask you a question about the groynes that have been constructed from time to time for the protection of the coast line. You are familiar with the circumstances?—I am familiar with them up to the north of the harbour but not to the south. To the north of the harbour there was a great encroachment of the sea.

3635. That is in consequence of the harbour works?—Yes; I tried to stop that at first by throwing out groynes, so I know all about the ones to the north of the harbour; but the south of the harbour I have had nothing to do with, because the sand buried them all up there.

3636. That is just what I was going to ask you; do you know any of the details of those groynes; do you know about the length of the longest of them?—I cannot tell you from memory. I have them at Madras. At Madras I have old plans of them got out at Fort St. George.

3637. Has the sand ever stopped short of entirely burying them?—I do not know whether it has.

3638. What I mean is this; just comparing one of those groynes with the south side of the harbour, we anticipate that the sand will reach out as far as the harbour works go?—Yes.

3639. The contention of some of the witnesses is that the sand will not advance very much further than it is now. Are you aware of any groyne existing to the south of the harbour of Madras, where the sand has stopped short of the extent of the groyne?—No, I am not; but then, you see, all the time that I have been at Madras the harbour has been under construction, so that the south pier has practically been a huge groyne which has stopped the sand.

3640. I am looking at it from that point of view?—The sand has buried the groynes further south. They have been buried here, but they would not have been buried so soon, of course, but for the harbour works themselves. I have never had an opportunity of seeing the coast without the harbour works; that is what I mean.

3641. The harbour works have affected the groynes right along?—The harbour works have stopped such an immense lot of sand that it has buried the other groynes.

3642. Then we will go on with what prompted my question. General Sankey sees no difficulty in arresting the sand to the southward of the harbour works by means of groynes. Do you agree with him?—Yes, I agree with him. There would be no difficulty in that.

3643. Is that in accordance, do you think, with your experience?—It must be a very long groyne.

3644. Longer than the harbour?—Yes, it is no good putting out short groynes.

The witness withdrew.

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3645. (*Chairman.*) I think I may say that we see no reason to modify the result of our calculations as to the advance of the sand, unless you think you can put anything before us that will enable us to do so?—Well, I hardly know what your conclusion is.

3646. The conclusion is roughly that according to the present advance of sand the four-fathom line will have advanced as far as the knuckle of the south arm within 20 years?—That being based upon a comparison of the advance of the two, three, and four fathom lines for the three years preceding 1882 and the four years succeeding 1882.

3647. Being based upon the soundings, as a matter of fact.—Those were the dates of the soundings, 1879, 1882, and 1886. I am bound to say that is a conclusion in which I cannot agree. I can hardly tell what facts you have taken into account in coming to that conclusion.

3648. Absolutely nothing but the soundings.—Absolutely nothing but the soundings. Then my conclusion is, that if with the soundings you combine the changes that have taken place in the levels which are not got by soundings, but which are got by observation, you get a very different result. Of course you have seen the table that I handed in.

3649. Quite so; I quite realise the difference between your view and ours?—You remember that my conclusion is not based at all upon that table. It was come to, I may say, before this last survey was made, and with regard to that survey, all I say is, that it simply confirms my conclusion. My conclusion was formed independently of that, and I can find nothing in that in any way militates against it. It is exceptional, but it is an exception that I have been looking forward to any time these last 10 years, and it is nothing more than what I have expected every year. I am perfectly satisfied from that that there is not the slightest ground for believing that during, or at any time previous to, the year 1886 was there anything to encourage the idea of the rate of advance being accelerated by anything previous to that survey; but to my mind it completely bears out the conclusion which I had previously formed, that the advance is proceeding in a diminishing ratio; and when I compare the amount of accumulation that has taken place from the commencement of the works, with the space that will have to be filled before the four-fathom line passes the corner of the pier, I find that the time requisite for filling that is somewhere about 50 years from the present time. Now I should be very glad,—as you have said that you have formed a different conclusion from that,—to put on record some few of the facts on which that opinion is based; and I may say that it is based upon an accumulation of facts which have come before me for the last 10 years, and up to the present time I have found nothing in the slightest degree inconsistent with that conclusion. Before we go into the facts it is, perhaps, desirable that I should just mention one or two general principles that I believe are universally accepted, because it is to those principles that we have to apply the facts. The first is this: I believe it is generally acknowledged that where a light sea,—that is, a very moderate sea,—impinges upon a sandy shore obliquely, it drives the sand before it quite independently of any current. What the amount of drift in that way is, depends upon various circumstances, but it is essentially a fine-weather action—not absolutely calm, but with such an amount of sea as there is almost always at Madras. It is an action which takes place to the greatest extent between wind and water; just a belt over which each breaking wave washes up the shore, and washes down again. Every wave transports a certain amount of sand a few feet to leeward, at and near the water level, but the action very rapidly diminishes as you get into the greater depths. Now, assuming that *this* shore lies north and south, a south-east sea would naturally have the effect of driving the sand to the northward. A north-east sea would have the effect of driving the sand to the southward. I do not mention it as a fact, but I mention it as a principle, which is established by universal experience, and one that we may look for as likely to occur at Madras. *That* is with regard to very moderate seas. When we come to heavier seas we get a different result. These heavier seas are deflected into a line, in which the ridge of the wave is more parallel with the shore. They fall upon the shore consequently more parallel. There is less of the oblique action, and there is less of the lateral movement of the sand, but the effect of those heavier seas is sometimes to draw down the sand from the upper level towards the lower, and sometimes, under certain circumstances, but more seldom, the effect is to drive it up from the lower—the greater depths—up to the surface; so that sometimes from these seas you get an apparent accumulation; at other times you get an apparent erosion. Now that accounts for a fact of which we have some experience at Madras, especially with the north-east seas north of the harbour, if we have light north-east seas, such as come during the time of fine weather, in the north-east monsoon, we get an accumulation on the north side of our groins, or other obstacles. That, I should say, appears as an accumulation, as a growth of the high-water line outwards.

3650. I think, if you will excuse me interrupting you there, that is contrary to the evidence?—I beg your pardon; it is perfectly in accordance with the evidence. Here it is; every year we have watched the eating away on the north side of the harbour from year to year.

3651. Not an accumulation?—Not an accumulation immediately there, because it does not reach that. We have cut off the possibility of its showing as a sandy beach from a point about a mile north of the harbour, but beyond that, where we have an obstruction, or rather an indentation, the end of which is an obstruction, we have a constant erosion from year to year, and that annual erosion is the balance of an accumulation from September to March, and an erosion from March to September. Now, during the time that the north-east monsoon is blowing, it is being continually from time to time watched, and it has been observed to me by the staff out there that while the moderate monsoon seas are acting on the shore obliquely, there is an accumulation. If the sea gets heavier with the wind in the same quarter, still north-east, and still a north-east sea out in the offing, that north-east sea rakes down the sand from the upper level, and makes an apparent erosion, so that it is proved beyond all doubt that a moderate north-east sea produces an accumulation north of the harbour during the north-east monsoon; a stronger sea produces an apparent erosion. The erosion produced by the heavy north-east sea is merely temporary. It is washed up again in course of time, and the total effect at the end of the year is that there is a little more erosion than there was in September of the previous year. Now that applies to the north coast of the harbour only, and I mention it because it has been frequently observed there that there is this apparently different action of the light seas and heavy seas; but on the south of the harbour we have precisely an opposite effect, so far as the accumulation is concerned. *There* we have not an annual erosion, but an annual accumulation, and, until last year, we never had any exception to that. The curious thing, to my mind, is that it should have gone on for 10 years without showing any exceptional result; but, for the first time last year, we did get one of these heavier seas, during the season in which accumulation is generally going on, which had the effect of drawing the sand down from the land, and depositing it at two and three fathoms. It does not appear to have gone much beyond four fathoms, so far as we can judge, but it has drawn it down from the top and deposited it between the two and the four fathom lines. Now, the fact that weighs very strongly upon my mind is that this annual advance is so very regular.

3652. (*Sir John Coode.*) Advance of what?—Of the shore line to the south of the harbour.

3653. (*Chairman.*) The high-water line?—The high-water line. It begins with some considerable width and with very slight irregularities. It goes on getting narrower and narrower up to March 1886. Now, in May 1886, there comes a heavy cyclone sea, the first that we have had in the month of May. We have had them in November, but we have never before had them in May. I confess I have some ideas upon the subject, although I cannot put them forward as facts, as to why this May cyclone should act differently from the November cyclone. The November cyclone does rake down the sand to a certain extent, but it appears to be more quickly recovered. The effect, however, of this May cyclone was to cause a very considerable erosion in the shore line, and so great that it was not recovered even by the following March, so that the March line

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of 1887 shows itself really farther back than that of 1886. This is the case for a distance of less than half a mile, say a third of a mile, from the harbour. It is actually farther in shore than the 1885 line was, and nowhere does it come out so far as the 1886 line. Now that shows beyond all doubt that this must have been a very exceptional case. What has become of that sand? Where has it gone to? The advance of the two, three, and four fathom lines shows very clearly that it has gone down there. The effect is one which we have repeatedly seen at the north of the harbour. It is one that we have been every year expecting here; and is it not a very natural thing that we should attribute it to that foreseen action of this unusually heavy sea, drawing down the sand from the upper to the lower level? As the table that I presented to you I took into account the erosion of the upper levels, and combined them with the accumulation of the lower levels, and I find from that that the advance in the first three years was 97 feet a year, and that the advance in the last four years was at the rate of 71 feet a year. Now that certainly appears to me the fair way of looking at it, and if it is so taken, it appears to me that this is simply a temporary interruption, and merely a temporary interruption of the regular rate of the advance. I may mention why I took the month of May instead of the month of September for the upper levels. The reason is, that I wanted to get at the result of that May sea, without any of the disturbing influences that followed it. If I had taken the September advance throughout, it would have included the accumulation in the fine weather after the storm, and the upper levels would have shown an advance not due to the storm. The September survey of the lower levels can safely be taken as showing the effects of the May storm, as the fine weather action would not extend to them. The great point in my mind is that those regular parallel lines must be attributed to some regular annual action. They cannot be produced by exceptional storms occurring at irregular intervals. They must be due to some regular fine weather action, and it is quite consistent with all we know of the action of waves upon a beach, that the very moderate seas, which occur with little more than the land and sea breezes, have really more effect in the transport of sand along shore than the heavy seas which are deflected so as to be parallel with the shore, and merely draw the sand down, or drive it up.

3654. We quite understand your point; but have you compared the amount of erosion due to that cyclone, with the regular increase of deposit of which we have very clear evidence?—Yes; I think this is decided. I think the evidence you speak of is given in abstract in this table which you produced the last time I was here, and which shows this going on at a greater rate the last four years than the former three years. That is the result you put forward?

3655. Yes.—I quite accept that result as affecting the three lower contours; but I say you get a false conclusion, unless at the same time you take into account the two upper contours.

3656. I think we must narrow the issue. Your conclusion is that that will not go on at the same rate?—That is certainly will not go on at the same rate with the lower contours. Another storm may produce a similar result; but, as we know, it may be years before that occurs, and in the meantime there is the regular fine weather action going on; and it is to that alone that the growth is due; I say now, advisedly, it is to that alone that the growth is due. Ten years ago I should have spoken more doubtfully about it; I should perhaps have said: "We know the fine weather produces such and such a result," and I would not have been very confident that the heavier weather might not have produced a greater result; but now, after the last 10 years' experience, I say positively, according to my own opinion, that the exceptional weather does not produce any appreciable result in the permanent advance of sand, that that advance which is shown upon that survey which you have very properly been studying, is a temporary advance and confined to the deeper contours. I do not say that that particular sand will ever be moved again; but it will wait there until it is overtaken by the slope which comes down from the advancing high-water line.

3657. I quite see your point of view; but I must confess I cannot see what difference it makes to the harbour works where the sand comes from, so long as it comes there?—My point is, that it has not come except by this fine weather action, and that fine weather action we know how to meet; we know we shall not have to meet it for something like 50 years, and when that 50 years has expired, if we then to have to meet it, we know what we have to meet, and at what cost it can be met. If you throw that all overboard, and say, "We have not the slightest idea where all this sand comes from, or how it can be prevented, or anything "at all about it," I can only say that as a responsible officer of the Government, I can advise them to do nothing but to suspend the works until time has settled the matter, which I think it would do in a few years; I could not advise them to spend another 100l. upon those works if they accept your conclusion.

3658. Would that affect your opinion as regards opening an entrance at the north-east corner?—There are so many points connected with that, that I think I may say, if I understand the spirit of your question, it would not, because I do not think that this sand question really does affect it. The accumulation of sand involves an expenditure at the end of 50 years. I do not think we need take that expenditure into account. It may be that if you have the entrance in its present position it will be required in 50 years; if you move it to the north-east it may take a few years longer, but I cannot form any idea of the way in which the accumulation will spread along that part of the coast, but with such a distance of time as it is, I should be inclined, myself, to put that out of the question altogether. I think as far as the suggested (I cannot call it proposed) south-east entrance is concerned that there it would come in, because there it would bring the accumulation many years nearer, and also, it is continually diminishing the area of deep water within which ships have to manœuvre, but as far as the difference between the east entrance and the north-east entrance is concerned, for my own part, I put it out of the question altogether. But I should really be very glad to consider the matter, if there are any other facts that you think have led you to this conclusion; because you must be very well aware that it is a thing that has occupied my attention now for a great many years. I believe I am the only person who has really studied it; but everybody appears to be perfectly satisfied with the conclusion I have arrived at. The last time that it was questioned, was by Sir Andrew Clarke, in 1879, but he virtually withdrew his objections afterwards—at any rate, the Government paid no attention to them. Since that time, it has been accepted—I might say unanimously—that the advance of the sand is not a thing that we need take into account. Of course, if this survey had produced anything new, it would be quite right to take it into account, but I maintain, and it is perfectly clear to my mind, that it has produced nothing new. It has produced nothing more than we have all along been expecting, and I do not believe that a ton of sand has been moved—perhaps that is putting it rather strongly—but I do not believe there has been any appreciable alongshore movement as the effect of that storm.

3659. (*Sir John Coode.*) You seem to ground your conclusions upon the fact you have stated to us, that September 1886, indicates an abnormal state of things as regards the advance?—Yes.

3660. Have you considered that it has been growing, I will not say regularly, but with comparative regularity, since the work first commenced, and that the rate of advance which we have taken into account has been that (and only that) since 1879, when the south pier had arrived out to the knuckle. Now, why should 1886 be taken as indicating an abnormal state of things, seeing that September 1879 and September 1882 show practically the same profile?—They are, practically, the same, but you have not got the profile above this (*pointing to the plan*). That, I imagine, is the two-fathom depth, is it not?

3661. Yes, that is the two-fathom depth?—If you had this plotted up to the top of the accumulation, and if you plotted that to the line of May, you would see that there is a very considerable difference. I think that the way in which I take it, which virtually depends upon the advance of high-water line, is the true one.

3662. There is the essential difference between us?—Excuse me; I think we shall find out that we are both right. It is not an essential difference between us. I take the high-water line as a basis for my own mode of calculation, which differs a little from yours; but I think it is a true one. Taking the month of March,

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when it is at its extreme landward position, I think it it is a very justifiable conclusion that the slope from that down into deep water is virtually the same every year, and what the exact form of that slope may be is a secondary matter.

3663. Mr. Thorowgood has told us almost in so many words, that this is a surprise to him, that he has never given his attention at all to what has been going on under the water?—Quite so; but then I must ask you to remember this—this sand movement is a matter which I have taken entirely into my own hands: Mr. Thorowgood sends me the data, and he has never gone into the calculations at all; of course he sees my results, and he is, I believe, perfectly satisfied with them; but there is nothing unexpected in that result—nothing in the slightest degree unexpected.

3664. Well, he hardly sees the reason for the introduction of the profiles above the two-fathom line?—I cannot account for that.

3665. What he sees is what you told us in the early stage of your evidence, that he has always understood that the four-fathom line has been the standard for comparison, and so it was to a certain extent?—So it was, and to a certain extent it is, but it is a standard for comparison only in my mind to this extent, that I feel quite certain that it is a safe standard for the assumption that outside four fathoms there will be no alongshore movement under any circumstances. I believe, even if I were to take two fathoms as a standard that I should be virtually safe—that is to say, that outside two fathoms there is no movement such as to be of any consequence; I take four fathoms as being on the safe side, but the great bulk of the movement is between wind and water.

3666. But the sand having once got below the two fathoms depth, I suppose you do not expect any very great change to take place?—I should never expect it to have recovered yet.

3667. That is our difficulty?—But it would be a long time before the slope which is advancing from high water, covered that accumulation. Instead of, perhaps, four years, it would really represent the advance of six or seven years at the two-fathom line.

3668. That is our difficulty. Having once got below the two-fathom line, how the depth is to be recovered again?—I am afraid it would not be. I do not look upon it that there is any necessity to recover it. I do not think the waves will ever wash it up again, but that it will simply remain there as a base for the sand which is brought along shore at the higher levels to rest upon.

3669. Here we have three different periods since the commencement of the works, and during each of those periods there has been a very material advance not only of the four-fathom depth, but also of the two and three fathoms?—Yes.

3670. What we fail to see is, what is to prevent that accumulation continuing?—At present what would prevent its continuing is this. It must be washed down from the higher levels, and at those higher levels from the two fathom up to low water, and again from low water up to the top of the accumulation; it is very much flatter now than it was in May 1886, when it was attacked.

3671. In Mr. Thorowgood's evidence this morning, he stated that, having been perfectly clear in the morning, after an interval of an hour the water would be very materially charged with sand, even outside the works. Your view, pardon me saying so, is, I think, far too limited a one. You seem to conclude that the only sand which accumulates there is that which is clawed off the beach. If this water is so highly discoloured with sand seaward of the works, surely some part of it must be brought up from the south, and meeting with the obstruction of the south pier, is deposited in deep water?—There will be some; and that deposit which I called your attention to in the first instance, and which weighed with the committee at first—that deposit off the knuckle of the pier—is formed, I believe, in that way, and, although I do not put it forward as a very positive opinion, yet I think it is very probable that the reason why we did not observe that before is that these severe storms have occurred in November when the normal current is from north to south, and in the same direction as the storm current made at the time by the storm. Well, that would carry this sand away clear. When you get a May storm, the normal current is from south to north. The storm current is from north to south, and the two, for the time being, neutralize one another; you get, for a time, still water there, and the sand is deposited. That is the way in which I am inclined to account for it; but one single instance of this is hardly enough to make one disposed to be very positive upon such a matter as that, but I feel as positive as it is possible for a man to be, that the great accumulation of sand is caused by that alongshore movement in fine weather, and I do not think that the slight irregularities and changes that we have in deep water are of any consequence whatever as compared with that.

3672. Looking at those two sections to the south of the south pier, would not the existence of this long flat slope indicate an accumulation as far out as the knuckle; would not that seem to indicate to you that the accumulation against the south pier is taking place from the sand which is brought up from the southward, in deep water, rather than from that which has come off the beach?—*This* is the line of the section.

3673. That is the line which the section takes?—*That* distance is how much—300 feet?

3674. Three hundred feet. *That (pointing to the plan)* is 550 feet. It happened to be on one of your line of soundings. What does appear to me to be a proof that a certain proportion of this sand is being gathered by that pier, acting as a groin rather than being clawed off the beach, is the existence of this long flat slope, corresponding with the pier?—Yes, I am very much obliged to you for pointing that out, because what I want to get at is what is weighing in your mind to produce a conclusion so different from mine. I certainly think, that at a distance of 300 feet from the pier there would be a great deal of disturbance that you would not find at a greater distance from the pier.

3675. That is, unfortunately, a part that affects the question of the sand accumulating against the pier?—The growth here of the lower contours is no factor at all in the rate of accumulation along the whole line of coast. There may be some disturbance along here, and it may creep along there, but it will not creep to any serious amount. You have gone more into these sections than I have done. It is not that I have neglected observing the advances there, but I have always felt that that is a matter that could not be satisfactorily got by sections alone. It requires a mode of treating the matter which takes really a more comprehensive view, and that I think is done by the mode that I have indicated of the advancing high water line at the most regular periods when subject to fewer exceptional changes, and then the assumption that the slope from that will be virtually constant from year to year. Having the same cause it will produce the same effects. You get a certain slope in May 1883, and if you find that in May 1884 the high-water line has advanced in the regular course, you may assume that the slope from the high-water line downwards towards the sea is the same as it was the previous year. When you get an exceptional case at high water you may be perfectly certain that the circumstances below water will be also exceptional, and for that reason I have not been inclined to take that particular survey as the basis of any calculations as to parts of the survey. I treat the survey as a whole, and I find that it bears out my conclusion.

3676. If we had had this particular survey alone to compare with the first we should probably not have attached so much weight to it, but when we have got two intermediate surveys which generally bear out the same thing, we think we are warranted in the conclusion we have come to?—You think that the contours will take something like that form (*describing*).

3677. It does not so much matter what takes place at a distance of 700, 800, or 1,000 feet from the south pier. What concerns us is the rate at which this accumulation is taking place at the back of the south pier, and this guides us in the determination of the period when the sand is likely to reach the knuckle?—That period must depend upon the quantity of sand that comes.

3678. Of course it does mainly depend upon the quantity of sand that comes, but as to the particular angle with the whole shore, that is a matter of very little moment comparatively speaking. What we look at is the growth that is taking place at the back of the south pier.—Do you go into the question of what feeds that growth?

3679. It is the sand coming from the southward that feeds it.—It is the sand coming from the southward that feeds it. I go a step further. I measure the quantity of sand coming from the southward and I say,

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although there may be certain irregularities here immediately contiguous to the pier, yet the quantity of sand is actually measured by the width which it has advanced in the course of a year, multiplied by the length along shore and the depth seaward, and that will give room for very considerable irregularities here, without materially affecting the whole result.

3680. That is a question of cube quantity?—That is a question of cube quantity.

3681. What we are concerned with is the seaward growth?—The seaward growth is dependent upon the cube quantity, is it not?

3682. It is dependent upon the cube quantity, but in this case we consider the gauge of the whole thing to be the seaward growth at the back of the south pier?—You see you have taken it at 300 feet off the pier. I have always considered that it would be unfair to take it close to the pier, and I doubt whether 300 feet off is enough. I quite admit there will be certain disturbances near the pier. There will be the deflection of the waves, and there will be a certain amount of current, and all this will disturb it, but the quantity so disturbed is not large enough to be of any consequence. There is a great depth of water there—there are 8 fathoms of depth.

3683. To show you that there is nothing exceptional in that, if we take the three years from 1879 to 1882, the seaward growth per annum on the line 300 feet south of the south pier was 72 feet; the average growth for the whole 1750 was 80 feet, or even more?—On which fathom line?

3684. On the 4-fathom line?—I do not happen to have the section with me.

3685. It is clear from this table that there is nothing unfair in taking that 300 feet from the south pier?—I do not think there is any more than this, that I think it is within the limit of disturbance, and even if there is a little more determination of the sand to that point. I think the great thing is the rate at which it comes.

3686. We consider for our purposes the rate at which it comes is gauged by the growth seaward. That really is the point we have to consider?—Then the growth seaward must depend upon the feed.

3687. (*Chairman.*) Have you had any experience of any other groynes along the coast that have been put up for the protection of the line of the coast?—Not personally; but there have been groynes along the coast there, and the Madras engineers consider that they have complete control over the line of coast. The Fort St. George, which lies about a mile and a half down here (*pointing to the plan*), was entirely saved by groynes.

3688. Do you know that those groynes have become merged in sand?—They are buried now, I believe.

3689. Yes, I believe they are buried entirely?—I believe you were told they were washed away, or something of the sort. They are in the sand there.

3690. Do you know the greatest length of those groynes?—I cannot tell you that, but certainly to stop a year's accumulation of sand it would take 600 or 700 feet from high-water mark. Then it would stop it effectually. I do not think the old groynes ever went more than 200 feet.

3691. To stop it for a year?—Yes; it may also be stopped in this way: By putting four groynes of 200 feet each at distances of perhaps 100 yards apart, and that is the way in which they worked. They did not stop it by one groyne, but by putting three or four, so that the overflow from the one was caught by the second, and that is equally effectual.

3692. Then do you agree with General Sankey that the sand could be prevented injuring the harbour by means of groynes?—Yes; I quite agree with him there. On one point I do not agree with him, and that is that ultimately there will be an equilibrium and no further advance. I do not see what ground there is for thinking that at all. I think it will go on as long as the supply of sand from the southward lasts, and I do not know when that is to stop; but that it could be kept completely under control and that at an expense which would not be at all out of proportion to the revenue of the harbour, I am perfectly satisfied, unless you throw doubt upon the whole conclusion—I will not call it theory, because I do not think it is one—and say "we do not know where the sand comes from, or what it is going to do." If you do that, then I say Madras is not a place for a harbour at all. I should like to try myself upon those sections, making them complete up to the top line of the accumulation, and I think that that would show very clearly what an exceptional state of things it was in September 1886, or in the year 1886, I will say. May was the time when the exceptional state of things was produced.

3693. (*Sir John Coode.*) I do not quite understand what it is you suggest?—It would be simply completing that section, or laying down upon it the line of low water, or the datum line, rather, which is not low water.

3694. I understand that the part between high water and two fathoms we cannot get on account of the surf?—No, you cannot get that.

3695. Have you profiles of the beach between half tide and high water?—Yes.

3696. I do not see quite what you can do if you have not got the true profile?—It would show this, if you compare the high water lines: for instance, you might lay down the high water line there for 1882—it should be really March for this reason, that March is regular, and September is irregular. In the month of September the slope is naturally steep. The high water line is at its maximum position seaward, and is naturally steep and is liable to small changes by the sea. In March it is permanent for a couple of months. In fact, we took the surveys on the 28th February generally, and called that March; but for the month of February and March it is fairly permanent, so that it is better to show the positions in March than in September, but if you were to put down here the position of high water mark in March 1887, and the position of high water mark in March 1882, and again in 1879 you would see what a very exceptional state of things it is.

3697. The difference between half-tide level and high-water mark on the scale of [illegible] what—about a 32nd of an inch, would it not. [illegible] would not be more, would it, it is only just a very thin line?—No. I have got it here. Suppose we get it only approximately.

3698. What is the mean sea level. Is not the high-water line a foot above it?—Yes, it is rather more than that. Then there is five or six feet again above that. It is not that, it is the position of the high-water line that I mean, measured by the horizontal scale.

3699. It does not appear how that is going to throw much useful light upon the subject, because you have just said, and we shall all agree upon that point, that the sand having once got below the two-fathom level, will not be carried back again in any appreciable quantity?—No, it will not; but you must go a little further than that. I admit that it will not be carried back again; but what I say is this: until we get another exceptional storm of this kind it will not advance until at least after the annual advance has reached that point. If I understand, your idea is that the two, three, and four fathom lines will go on advancing at a greater rate than the high-water mark will in the immediate neighbourhood of the pier.

3700. We put aside the high-water mark; what we conclude is that the accumulation will go on advancing in the same ratio from this time forward as since the south pier reached the knuckle?—Then do you think that the accumulation is taking place at the two, three, and four fathom line and not at the higher levels?

3701. No; what is important for our purpose is—and we have regarded the matter all along from that point of view—the accumulation that has taken place below the two fathom line, and consequently the extent to which the navigable depths are affected?—Do you think that it is accumulating at the two fathom line faster than it is accumulating at high-water mark, or making an advance independent of the high-water advance.

3702. To some extent it is. The slope of the section goes to prove it.—I admit that the sea may have some effect in the immediate neighbourhood of the pier, in determining the slope there. It may be within the influence of the pier. It may be rather a different slope from what it is further away, but I think that the advance must be dependent upon the sand which is brought along shore, and which is brought at a higher level. The high water mark must advance before the two-fathom line can advance.

3703. It depends upon the sand which is brought along the coast by the southward?—It is brought along by wave action, you admit, do not you?

3704. Yes, I admit that. But if I rightly understand your view, and I think I do, we must regard this only

Mr. W. Parkes, M.Inst.C.E.

8 Aug. 1887.

from the point of view of the sand which is brought immediately along the shore?—Yes; between wind and water.

3705. That is not our conclusion. We have heard from Mr. Thorowgood this morning that the quantity of sand with which the water is charged is such that sand to the extent of the 32nd of an inch is deposited in a bucket of water after the lapse of an hour when the water had been so clear an hour before that he could see the ripple marks at a considerable depth. If the water outside the works is so highly charged with sand as that, it certainly goes to bear out this: that the accumulation is independent to a great extent of the quantity of sand which comes along the beach, and the flat slope of this section immediately to the south of the pier, as compared with that 500 feet further to the south, goes to prove it?—That is, in fact, that the curve instead of coming sharp up to the pier and meeting it an angle, the contour line forms a sort of a curve.

3706. It is, in fact, that the south pier acts as a groin itself, as an obstruction to the extent that admits of an accumulation of sand independently of that which is clawed down from the beach?—That sand being brought?

3707. Along the coast; not necessarily along the shore line, but coming up from the southward, the whole water is charged?—Where does the sand come from with which the water is charged? I imagine it is just washed up from the shore by the waves.

3708. It comes up the coast from the south?—Of course it comes from the south, but it is only during exceptional seas.

3709. Oh, no.—It is only during exceptional seas that it is charged in that way.

3710. Mr. Thorowgood described this as very fine weather, and I asked him what was the difference in the circumstances between the time of the day (I think he said it was about seven o'clock in the morning when he saw the sand ripples at a considerable depth) and the state of things when the water was highly charged with sand to seaward of the works, and he replied, to the effect that there was a slight breeze, or a light breeze not affecting the surf?—And that that caused the normal effect.

3711. Whether that caused it or not, he gave us the difference in circumstances?—Quite so.

3712. (*Chairman.*) He was asked whether we might attribute that to the breeze, and he said: "No, that is the worst of it," and he replied also to the effect that he could not account for this discoloured water; he stated the average number of days on which the water was charged with sand in suspension, as being 40 days during the south-west monsoon?—About.

3713. (*Sir John Coode.*) At the same time, he said it was very capricious, and he quoted this particular instance as an illustration of his remark. He said about 7 o'clock he was out at the back of the south pier; he was struck by the clearness of the water; he traced the sand ripples at a considerable depth, and he said that an hour after that the water became so highly charged with sand that it extended outside the harbour itself, and that he took up some water in a bucket and that the deposit was a 32nd of an inch. A further question was asked him as to whether there was a strong breeze and he said, no, there was a light breeze that had sprung up, but he did not seem to think that that was sufficient to account for it?—Just so.

3714. (*Chairman.*) There was not enough wind to interfere with the survey.—Now, if I understand, you admit my explanation as far as it goes, that there is a travel from the southward which is only partially removed by the travel during the other part of the year from the northward, and that that makes an accumulation of the shore generally for some distance from the harbour; there, I understand, you agree with me?

3715. (*Sir John Coode.*) Up to that point we do?—Now we come to a point which you have now raised, and which is new to me, and which I am anxious, I confess, to thresh out. I will not say that you are wrong, but it is new to me, and that is, that in addition to this there is some action by which the sand is stirred up in this angle between the shore line and the south pier which causes a deposit to be carried out beyond the line of the pier; is that it?

3716. Yes, that the growth does not depend entirely as you seem to conclude upon the quantity which is clawed down from the beach. That is the point. Mr. Thorowgood himself expressed a surprise at what was going on under water; but he said at the same time, very properly, his attention had been devoted to carrying on the work with which he was charged, that he had not attended to this, but that he was at the same time surprised, and I may say that I asked him to test it. He has measured *this*, and measured it independently, and he makes the growth in the case of the four-fathom line the same as we do, and the others ten feet more?—I do not question for a moment the measurements you have taken. I only say that they are not complete, that what you now give is totally independent of any conclusions to be drawn from that section, though that section may at first have suggested it to you. I think it is almost better shown by the contours.

3717. It is difficult to imagine anything more instructive than this section. Of course we had no idea how this would come out, until they were plotted?—Do not think I am questioning the sections in any way.

3718. They show most conclusively and satisfactorily that there is no loss of depth on the north side of the harbour, which really is exceedingly useful anchorage ground, from what we have heard from some of the captains, nor is there anything at present like an anomalous position for me to take to ask you questions, but am I right in concluding that you look upon 20 years as the life of the harbour. Is that a fair conclusion to draw from your point of view.

3719. That is a matter rather for the Committee, after considering the evidence, to conclude.—This is evidence of your own, as it were. I have not put it forward, but it seems to me to be a most important matter.

3720. So far as it is evidence of ours it is evidence drawn from your data?—Quite so. I do not for a moment question that.

The witness withdrew.

[Adjourned].

G.O. 80 Sta 153 W-16-1-8
W-44 W-4-2-88
W-76 W-6-3-88
+ Note of Evidence
Mr Molesworth's Note

Note by Mr. G. L. Molesworth, Consulting Engineer to the Government of India for State Railways, dated 5th May 1888, on the subject of the best position for the entrance to the Madras Harbour.

When I wrote my last note on the Madras Harbour, I had not seen the minutes of evidence which induced the Committee to prefer Plan No. III on "Nautical grounds," I have now had an opportunity of studying that evidence, and I would suggest for consideration a slight modification of the plan I originally suggested (marked No. IV). This modification consists simply in prolonging slightly further the eastern arm which I had suggested; and also slightly altering the tangent point from the north-eastern elbow so as to change its position instead of having it in the position in which it was originally built.

I have shewn the prolongation of the eastern arm sufficiently long to cover the opening and protect it from seas coming in, even at an angle of 30° from the normal direction.

In my report on the Madras Harbour, dated March 1st, 1882, paragraph 96, I advanced the opinion that "the *waves of a dangerous character must always "come in broadside to the shore or nearly so* whatever the position of the storm," and in paragraphs 75 and 76 of that report, I gave my reasons for the opinion I advanced. This opinion is confirmed by the experience of nautical men, as given in the evidence. The direction of the waves is stated to be quite independent of the direction of the wind, and that the heavy swells come in nearly broadside to the shore, even when the wind is blowing off the shore. Others state that the direction of the waves never exceeds an angle of 30° from the normal, but I doubt very much whether any waves, except those of oscillation, which are comparatively harmless, can possibly come in at any angle approaching this.

In fact, it is opposed to the laws, governing the motion of waves, that a *wave of translation* should deviate to any considerable extent from the parallel of the general direction of the contour lines of the bottom of the sea to seaward of the harbour.

An arm covering an angle of 30° will, however, be on the safe side, as protecting the entrance to the harbour, even from waves of oscillation.

I annex a sketch shewing the modifications I would propose in my original suggestion. The existing work being shewn in black lines; my suggestion of July 1883 in red lines; and the slight modifications I now propose in blue lines.

These modifications will, in my opinion, meet any objections that may be raised on "nautical grounds" to my original suggestions, whilst they will be free from some of the objections to which Project No. III is exposed.

G. C. Press, Simla.—No. 200 P. W. D.—18-5-88.—50.

92

MADRAS HARBOUR

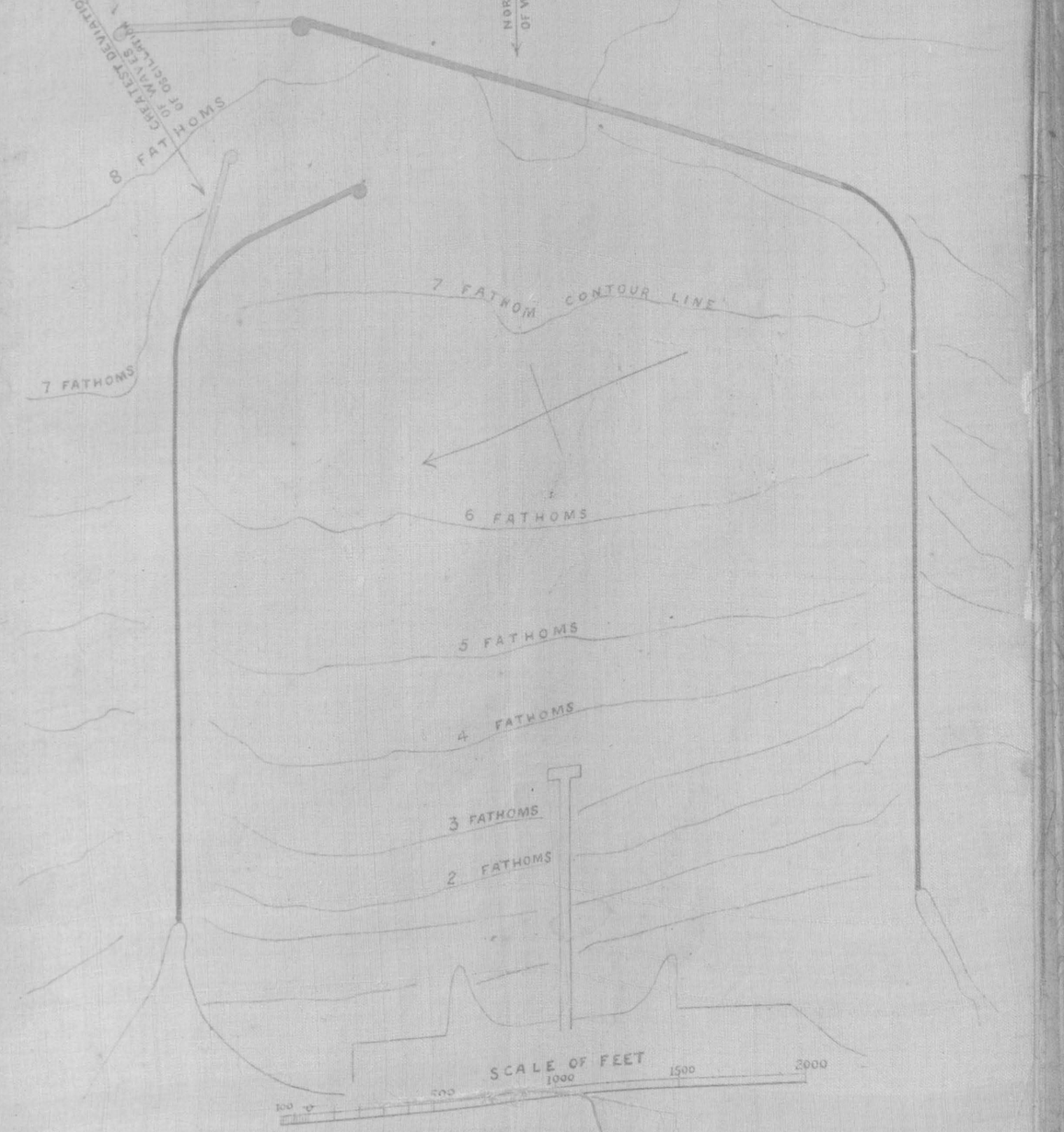
ORIGINAL WORK DENOTED THUS _____

PLAN PROPOSED BY Mr MOLESWORTH JULY 17TH 1883 _____

MODIFICATION PROPOSED BY Mr MOLESWORTH MAY 5TH 1888 _____

SKETCH TO ACCOMPANY THE NOTE OF THE CONSULTING ENGINEER TO THE GOVERNMENT OF INDIA FOR STATE RAILWAYS, DATED MAY 5TH 1888.

Guilford L Molesworth



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MADRAS HARBOUR

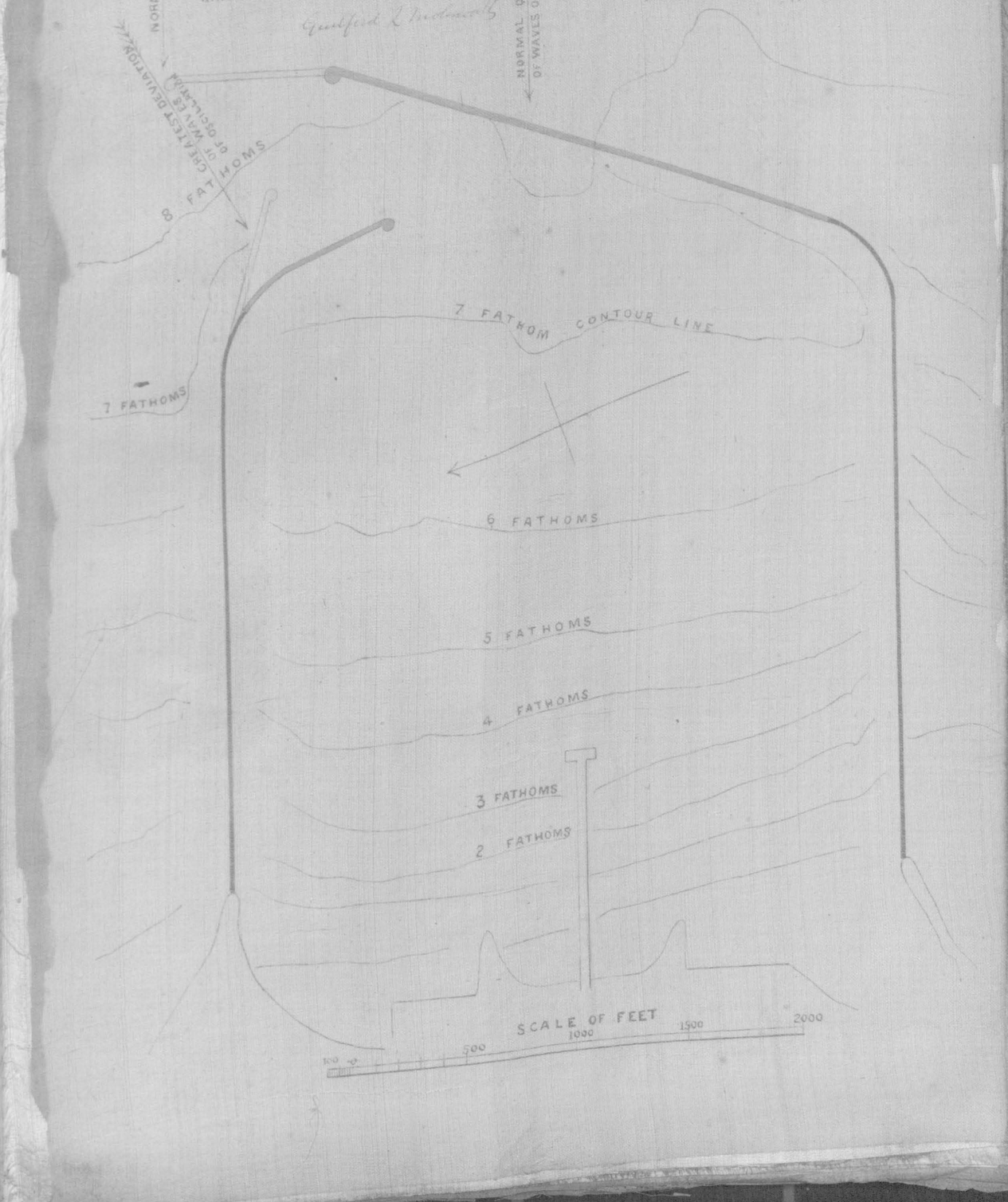
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G. C. Press, Simla.—No. 209 P. W. D.—18-5-88.—50.

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MADRAS HARBOUR

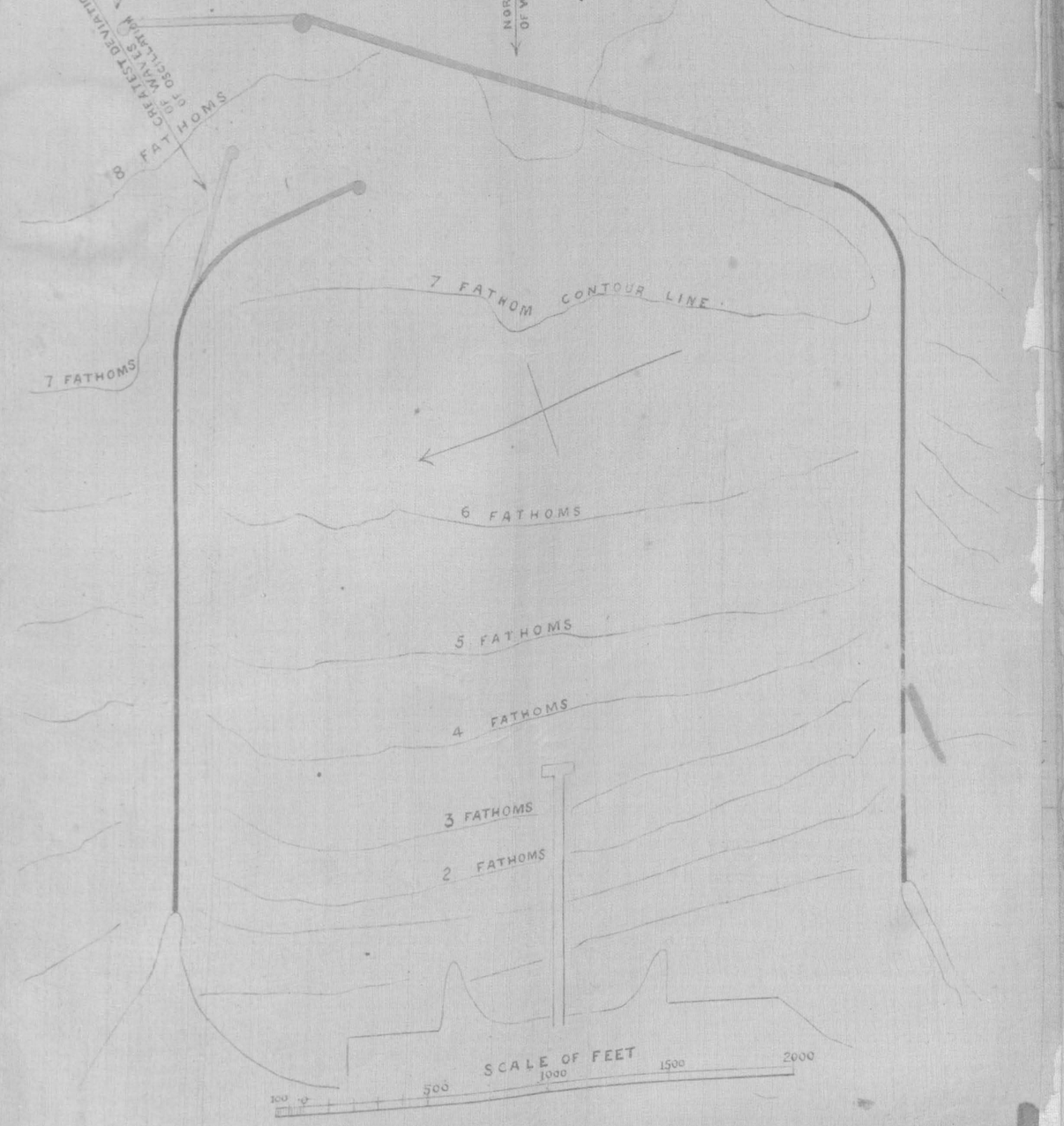
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No. -

GOVERNMENT OF INDIA.

PUBLIC WORKS DEPARTMENT.

CIVIL WORKS.

Miscellaneous.-

SECRETARY TO GOVERNMENT
1 JAN 8
P.W. DEPARTMENT, MADRAS.

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To

The Secretary to the Government of Madras,
Public Works Deptt.

Simla the 23rd May 1888.

Sir,

In continuation of Public Works Department No. 106 M dated the 28th February 1888 I am directed to forward for the information of His Excellency the Governor-in-Council the accompanying Copy of a further note dated the 5th May 1888 by Mr. Molesworth, the Consulting Engineer to the Government of India for State Railways, on the subject of the best position for the Entrance to the Madras Harbours.-

I

Madras 8th January 1880

Sir,

Your Most Obdt Servt

W. B. Buckley.

Under Secy to the Govt of India

Public Wks

Documents accompanying

Copy of Note by Consulting Engineer
to the Govt of India for E. Railways
1/6th May 82 & Sketch thereon referred to

Commanded to
the Honble Members
of Board for
Early report on
continuation of P. &
Ry & of Land on

Sir
I am
the Honble Members of
Committee of Inquiry
Public Wks Dept &c &c

GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

Buildings and Roads.
Civil Works.

Read—the following papers:—

G.O., dated 25th April 1888, No. 151, Marine.

Read—the following letter from R. W. BARLOW, Esq., C.S., Chairman, Harbour Trust Board, to the Chief Secretary to Government, dated Madras, 6th April 1888, No. 69:—

I have the honor to acknowledge the receipt of G.O. No. 153 W., dated 16th January 1888, forwarding a letter from Mr. Parkes addressed to the Under-Secretary of State for India, dated 25th November 1887, and to submit, for the information of Government, an extract of the Proceedings of the Harbour Trust Board at their meeting of 2nd March, confirmed at the meeting of the 8th idem.

2. The question of the position of the entrance has been most carefully considered and very fully discussed; and while the trustees "adhere to their former resolution as to the necessity of a north-east entrance, and (with one dissentient) prefer plan No. III, approved by the London committee, subject to any modifications that may be proved necessary hereafter," they are unanimously of opinion that smooth water is absolutely necessary to make the harbour a success, as without it very little practical progress can be made in the improvement of means for conducting landing and shipping operations, inasmuch as with an eastern entrance all improvements effected, in the way of providing large iron lighters, low level wharfage, &c., are liable to be wrecked by the free entrance of the heavy rollers accompanying such exceeding cyclone, or very heavy weather.

3. The Board do not think the harbour can be looked upon as a harbour of refuge from a cyclone, until experience has proved it such, and, at present, are of opinion that no ship would attempt to enter the harbour for shelter or, if inside, remain on the approach of or during a cyclone, if it should be at all practicable to put to sea beforehand; that, during the prevalence of such a storm, it may be taken for granted all shipping operations would be suspended; and that on its approach all vessels would put to sea and return when the weather had moderated.

4. It is absolutely essential, in the opinion of the trust, to the future prosperity of this port, that ships so returning should find lighters and machinery for loading or landing cargo, ready to go to work at once; and lighters and jetties, with cranes erected thereon, must depend for safety upon the smoothness of the water in the harbour. An eastern entrance will never give smooth water during at all heavy weather, and though a boat harbour, as proposed by Mr. Parkes, would secure the lighters, it would leave jetties and wharves in the harbour, with the cranes thereon, unprotected and exposed to certain destruction.

5. Referring to the three points dealt with by Mr. Parkes in his letter, the trustees would remark, with regard (*a*) to the question of the advance of the sand to the south of the harbour, that had the committee been in possession of the information referred to by Mr. Parkes in para. 22, they would probably never have alluded to the subject. The advance of sand to the south of the southern arm of the harbour is, the Board consider, a matter of no present practical importance, and has nothing whatever to do with the question, whether the best position for the entrance is east or north-east.

6. In reference (*b*) to the second point raised by Mr. Parkes, the Board unanimously approve the decision of Admirals Nelson and Nares and of Sir John Coode, and, as there are "two co-existing but conflicting judgments based upon the same evidence," would strongly urge their right to act upon the one which coincides with

their own unanimous views. It is in their opinion a most difficult task for gentlemen at a distance, who may never have seen this port in a cyclone, and are totally unacquainted with its business, routine, and requirements, to form a judgment. The Board would most emphatically urge that they are in every way best qualified to know what is wanted, altogether independent of a mass of conflicting testimony, which to all the gentlemen forming the various committees at a distance have to guide them.

7. Referring (*c*) to Mr. Parkes's third point, the Board agree with him in para. 29 that he had perhaps "rather exhausted than otherwise the difficulties of the situation;" they *prefer* plan No. III, but what they *want* is *smooth water*, ensuring safety to landing and shipping appliances in heavy weather. *Any* modification of plan III or IV or any plan which will give them this, within a reasonable cost, at a cost which the port can afford to pay, is all they have contended for as being absolutely necessary, and upon the absolute necessity of *smooth water* they do most strongly insist.

8. The Board do not approve of Mr. Parkes's modification "A," which presents the objectionable re-entering curve to the full force of a cyclone swell, immediately to seaward of a proposed entrance, and they understand that this is an objection previously hinted upon by all engineers who have been consulted.

9. The question of an alternative scheme brings me to the financial position and revised estimates.

10. Mr. Parkes estimates the extra cost of his new proposal, above sanctioned estimate, with 600 feet overlap, at Rs. 19½ lakhs, and with 800 feet, Rs. 24½ lakhs (para. 31).

On referring the question to their Engineer, Mr. Thorewgood, to estimate the probable extra cost *per Mr. Parkes's plan A*, at Rs. 24,15,375 and Rs. 27,14,250, respectively.

For plan III Mr. Thorewgood estimates the extra cost to be Rs. 27,79,163 and Rs. 30,66,363 for 600 and 800 feet overlap, respectively.

12. In estimating their financial position, the trustees prefer to take their own engineer's estimate made on the spot, and, in round figures, the result would be as follows, upon the date when it is anticipated that the works will be complete:—

600 feet Overlap.

	Rs.
Sanctioned estimate	46,55,000
Add extra for plan III	30,08,000
	76,63,000
	8,00,000
Deduct—	
Advances refunded as above	68,63,000
Capital advances outstanding, 1894-95	* 3,08,800
Interest thereon, at 4¼ per cent.	1,00,000
	4,08,800
Sinking fund	4,52,000
Income as above	43,200
Balance to credit of the trust	

13. In framing the above estimate the calculations have been based on actuals of previous years; the revenue from port dues is shown at Rs. 1,20,000 only, that being the amount shown in para. 11 of G.O. No. 15, dated 17th January 1888, after allowing for the reduction of Annas 1-6 per ton on liners, recommended by the Board in my letter No. 6974, dated 5th March 1888. The surplus of pilotage fees is taken from the actuals of 1886-87, Rs. 12,367. With regard to the item, Rs. 20,000 warehouse charges, the Board propose to supply, as soon as possible, a want very much felt in Madras by erecting warehouses and storing goods therein under warrant, in the same manner as is done in Bombay, where the Port Trust received in 1880-81, when the system was first introduced, *Rs. 30,716-6-1*, which in 1884-85 had risen to Rs. 97,280-15-3, or deducting cooly-hire, to about Rs. 85,000 net. The Board are of opinion that at least Rs. 20,000 might be raised from this source increasing annually.

14. Another source from which a large income might be derived is by saving in boat-hire, provided smooth water can be relied on in the harbour; this is now fully Rs. 1 per ton all round, the total tonnage handled yearly being between 2½ and 3 lakhs of tons. Taking the lower figure to allow for timber hauled on shore, calculating a saving of 12 annas per ton in boat-hire charges as practicable with smooth water, an additional revenue of Rs. 1,87,000 could be levied, as enhanced harbour dues, without imposing any additional tax on the trade of the port; and this sum, with the surplus shown above, is more than sufficient to meet all current charges, including petty construction. The reason why boat-hire is so excessively high at Madras is the insecurity of the investment in lighters, which are liable to be smashed to pieces at any moment, and which, under ordinary circumstances, soon become unserviceable, through constantly bosting up against each other, against ships' sides, and against the piles of the pier. Iron lighters carrying 100 tons each could, with smooth water, be safely maintained in the harbour, and loaded beforehand against the arrival of a steamer, thereby economising time. A charge for boat-hire of only 4 annas a ton, yielding Rs. 25 per trip, would be, if anything, too high, and more than would be needed to pay a handsome return upon a comparatively secure investment. But the Board do not wish, if it can be avoided, to enhance harbour dues, when smooth water renders a reduction in boat-hire practicable, one of the chief objects of the harbour being not only to facilitate but to cheapen landing and shipping operations, and they would prefer to allow the trade of the port to benefit, as much as circumstances will permit, by any reduction which may be found practicable hereafter. It would probably be sufficient at first to divide the saving effected between the Board and the merchants concerned.

15. I am further requested by the Board to ask that Government will suggest to the Right Honorable the Secretary of State that the rate of interest upon capital advances might be reduced from 4½ to 4 per cent. per annum, which would be of material assistance to the trade of the port.

* Decreasing annually by Rs. 4,800, the interest at 4½ per cent. upon one lakh of rupees.

16. In conclusion, I am desired by the Board to urge upon Government that the Board consider that Mr. Parkes is not sufficiently acquainted with this port to enable him to form a correct opinion of its requirements, and the result of carrying his theories into practice has already been far from satisfactory.

17. The Board have on the spot a staff of engineers who for many years have had the advantage of an intimate practical acquaintance with the harbour which, in its present condition, admits of completion within only very narrow limits of design, and the Board would earnestly represent that all details in reference thereto should be settled on the spot by themselves, subject to the control of the Madras Government, who can instruct their engineers to inquire into and examine any deviation from the sanctioned plan which it might be considered, in the interests of the port, to adopt. This would obviate the delays which have occurred hitherto through constant references to England.

18. The Board are quite willing to subordinate their wishes to engineering control, but would most strongly urge that this control should be in the hands of the Madras Government, and if any proposals which might be made were approved by that Government, the Board respectfully submit that the Right Honorable the Secretary of State might not consent that the matter had been carefully inquired into by competent engineering authority.

Extract of Proceedings of the Trustees of the Harbour of Madras, at a meeting held at the office of the Board on Friday the 2nd day of March 1888.

* * * * *

2. Read again, with reference to the question of the position of the entrance to the harbour, and minutes by the Chairman, Messrs. G. L. Chambers, J. R. Hunter, Captain W. L. C. Bathoby, R.E., Captain H. A. Stiffe and Mr. J. McLintock, and resumed point by point upon which they desired information and then withdrew.

Resolved that the best album to their former resolution as to the necessity of a meeting and endorse and prefer the plan No. III approved of by the London committee subject to such modifications that may be proved necessary hereafter. The Chairman is invited to submit to Government the views of the Board in regard to the despatch from the Secretary of State, dated India Office, 15th December 1887, communicated under endorsement under No. 153 W., dated 16th January 1888.

* * * *

Extract of Proceedings of the Trustees of the Harbour of Madras, at a meeting held at the office of the Board on Friday the 23rd day of March 1888.

* * * * *

2. Read draft letter from the Chairman, Harbour Trust Board, addressed to the Chief Secretary to Government, Marine Department, in reply to G.O. No. 153 W., dated 16th January 1888, communicating a despatch from the Right Honorable the Secretary of State, No. 11, dated 15th December 1887, forwarding a letter from Mr. Parkes, dated 25th November 1887, in reference to the question of the position of the entrance to the harbour.

Read minute by Captain Stiffe, Indian Marine, Captain W. L. C. Bathoby, R.E., Mr. Hunter, Mr. Chambers and the Chairman.

Resolved that this letter, as now amended, be submitted for further consideration.

* * * * *

Extract of Proceedings of the Trustees of the Harbour of Madras, at a meeting held at the office of the Board on Thursday the 29th day of March 1888.

* * * * *

2. Read again, drafted letter addressed to the Chief Secretary to Government, Marine Department, in reply to G.O. No. 153 W., dated 16th January 1888, communicating a despatch from the Right Honorable the Secretary of State, No. 11, dated 15th December 1887, forwarding

a letter from Mr. Parkes, dated 25th November 1887, in reference to the question of the position of the entrance to the harbour.

Resolved that this letter, as now amended, be approved.

* * * *

Order—dated 25th April 1888, No. 151, Marine.

Transferred to the Public Works Department with the following remarks :—

(1) According to the budget of the current year, reviewed in G.O., dated 7th March 1888, No. 215, Financial, the Board's total revenue receipts amount to Rs. 3,63,000. But this sum includes Rs. 20,000, interest on investments, which will probably have disappeared before the completion of the harbour, as the current revenue expenditure is at present considerably in excess of the receipts.* Again, the establishment and contingency charges amount, in round numbers, to Rupees 1,14,000, and the normal charges for petty construction and repair cannot be taken as less than Rs. 40,000 annually. (The amount provided under this head in present year's budget is Rs. 95,000). The Board's surplus under harbour revenue in years to come cannot therefore, on the present sources of income, be estimated at more than Rs. 1,29,000 (Rs. 2,83,000 — Rs. 1,54,000) per annum.

* *Revenue Account.* Rs.

Budget-estimate for 1888-89—	
Receipts	3,63,000
Charges	4,13,000

(2) The Board have now been appointed conservators of the port under Section 8, Act XII of 1875, and this will enable them to apply the surplus port revenues under that Act to the improvement of the harbour. But it must be remembered that the Government can at any time by an executive order remove them from this position. The Board will doubtless be able to effect a considerable reduction in the port establishment, and the revision of port fund accounts ordered in G.O., 17th January 1888, No. 15, will probably be favorable to Madras. But, on the other hand, the port dues on sea-going ships other than coasting steamers have just been reduced from 6 to 4½ annas a ton, and the Board estimate that this will reduce the receipts under this head by some Rs. 25,000. Allowing for all these changes, the port surplus available for harbour purposes cannot be reckoned at more than Rs. 40,000 per annum in addition to the Rs. 12,000 which the Board have taken credit for under Pilotage fees.

(3) The total surplus upon which the Board can now reckon will therefore be—

	Rs.
From Harbour revenue account	1,29,000
" Port fund	40,000
" Pilotage fees	12,000
" Warehouse fees	20,000
Total ...	2,01,000

or in all about 2 lakhs of rupees, to meet payments to Government which will amount to Rs. 3,98,000 if the 600 feet overlap is adopted, or Rs. 4,08,000 upon the 800 feet overlap, leaving a deficit of Rs. 1,97,000 or Rs. 2,07,000.

(5) The Board, however, consider that the saving in boat-hire will enable the trade to pay increased harbour dues without additional burthen, and hope to realise not less than Rs. 1,87,000 per annum under this head. That amount will more than cover the ordinary charges of the Harbour Trust Board, which have been omitted in the Board's calculations, but are included above, and will nearly meet the deficit above shown. The balance remaining may jointly be met by additional warehouse fees, of which the Board have adopted a minimum estimate; or must be provided for by increasing harbour or port dues beyond the amount of the estimated saving in boat-hire. The Government are at present unable to test the correctness of these estimates,

but they note that the anticipated saving in boat-hire depends on the certainty of smooth water, and this cannot be secured until the harbour approaches completion.

(6) It is evident then that, making full allowance for the fact that the interest on the accumulated sinking fund will, as time goes on, materially diminish the net charges, the Board will sooner or later be obliged to raise the harbour dues, or port dues, or both, in order to meet the increased liabilities which they propose to incur. Such increase, and more especially under port dues which have just been reduced, is, however, perfectly feasible, and may possibly not entail more than a temporary increased burden on the trade. There is also a considerable, though not at present ascertained, surplus to the credit of the Madras Port Fund, which will now be at the disposal of the Board as Conservator. On the whole, from a financial point of view, the Board's ability to repay the further advance now in question seems sufficiently established.

(7) Of course, if the Board's prayer for a reduction of the interest on capital advances from 4½ to 4 per cent. is complied with, the necessity for imposing fresh rates will be *pro tanto* diminished. The Government, in this department, consider that the request is a reasonable one, and deserves the favorable consideration of the Secretary of State.

(True Extract.)

(Signed) W. L. C. BADDELEY, Capt., R.E.,
Under-Secy. to Govt., P.W.D.,
for Chief Secretary.

G.O., dated 6th March 1888, No. 764 W., Public Works.

Read—the following paper:—

From R. E. BUCKLEY, Esq., 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 Calcutta, 28th February 1888, No. 106 M.

With reference to the Secretary of State's despatches, noted in the margin, on the subject of the best position for the entrance to the Madras harbour, I am directed to forward, for His Excellency the Governor's information, copy of a Note on the subject, by Mr. Molesworth, the Consulting Engineer to the Government of India for State Railways.

Nos. 19 and 21 P.W., dated respectively the 24th November and 19th December 1887, to the address of His Excellency the Governor of Madras.

Enclosure.

Note by G. L. Molesworth, Esq., *Consulting Engineer to the Government of India for State Railways, on the subject of the Madras Harbour.*

The committee, composed of Admiral Sullivan, Sir John Coode, and Sir George Nares, has now pronounced in favour of an entrance at the north-east portion of the Madras harbour, closing the present entrance to the east.

Of the four plans proposed, and marked Nos. I, II, III and IV, respectively, the committee records its preference to No. III on nautical grounds, but it does not state the nature of those grounds.

Plan No. I was originally proposed by the Madras committee in its report, dated June 30th, 1882; but when that report was referred to me by the Government of India for opinion, I pointed out in my Note of July 17th, 1882, the very serious objections to which this plan was exposed from its re-entering curve and from the action of southerly waves.

I also pointed out that plan No. II (which, in my opinion, was the necessary modification of No. I in order to remedy its defects) was open to the undoubted objection of throwing vessels, entering the harbour, further into shoal water than was desirable, and I suggested for consideration the alternative plan of extending one of the lines so as to cover the existing entrance as shown in No. IV.

In May 1887, Mr. Thorneycroft submitted, for the consideration of the Madras Harbour Trust Board, plans Nos. I, II and IV., and in addition to these plans he also submitted the modification of No. IV, as shown in plan No. III.

In No. III the extension of the face is carried out with a slight change of direction, whereas in the plan I suggested, the extension was in a straight line, on the prolongation of the face.

Mr. Thorneycroft, however, in putting forward plan No. III, accorded the preference to No. IV., which also found most favour with the Harbour Board for the following reasons:—

"(1st) That only a very small portion of the old ruined wall and rubble have to be cleared away.

"(2nd) That during the construction there will never be more openings than the proposed entrance through which the sea can come.

"(3rd) That it allows the work to be proceeded with at present at least for 4 months or more."

I may add that I prefer my original suggestion as it stands in plan No. IV to its modified form as plan No. III, because, in addition to the above-mentioned advantages, No. IV allows more sea room and involves less disturbance at the mouth of the harbour from the action of southwest waves. The relative estimates of plans Nos. III and IV are Rs. 61,00,000 and Rs. 62,45,000, respectively.

The ends of the mooring arm should, in my opinion, be turned inwards instead of outwards as shown on the drawings.

If No. III is to be carried out, I would strongly recommend a slight modification of it, as shown by the blue lines which I have drawn on the plan No. III that accompanies the report of the committee.

Order—dated 6th March 1888, No. 764 W., Public Works.

Communicated to the Harbour Trust Board for consideration, in continuation of G.O. No. 404 W., dated 4th February 1888.

(True Extract.)

(Signed) J. O. HASTED, Colonel, R.E.,
Secretary to Govt., P.W.D.

G.O., dated 9th June 1888, No. 1715 W., Public Works.

Read—the following paper:—

From the Secretary to the Government of India, Public Works Department, dated 23rd May 1888, No. 261 M.

In continuation of Public Works Department No. 106 M., dated the 28th February 1888, I am directed to forward, for the information of His Excellency the Governor in Council, the accompanying copy of a further Note, dated the 5th May 1888, by Mr. Molesworth, the Consulting Engineer to the Government of India for State Railways, on the subject of the best position for the entrance to the Madras harbour.

Enclosure.

Note by G. L. Molesworth, Esq., *Consulting Engineer to the Government of India for State Railways, dated 5th May 1888, on the subject of the best position for the entrance to the Madras Harbour.*

When I wrote my last Note on the Madras harbour, I had not seen the minutes of evidence which induced the committee to prefer plan No. III on "nautical grounds." I have now had an opportunity of studying that evidence, and I would suggest, for consideration, a slight modification of the plan I originally suggested (marked No. IV). This modification consists simply in prolonging slightly further the eastern arm which I had suggested; and also slightly altering the tangent point from the north-eastern elbow so as to change its position instead of having it in the position in which it was originally built.

I have shown the prolongation of the eastern arm sufficiently long to cover the opening and protect it from seas coming in, even at an angle of 30° from the normal direction.

In my report on the Madras harbour, dated March 1st, 1887, para. 96, I advanced the opinion that "the wave of a steep storm always come in broadside to the shore as surely as whatever the position of the storm;" and in paras. 75 and 76 of that report, I gave my reasons for the opinion I advanced. This opinion is confirmed by the experience of nautical men, as given in the evidence. The direction of the wave is stated to be quite

but they note that the anticipated saving in built-line depends on the certainty of smooth water, and this cannot be secured until the harbour approaches completion.

(6) It is evident then that, making full allowance for the fact that the interest on the accumulated sinking fund will, as time goes on, materially diminish the net charges, the Board will sooner or latter be obliged to raise the harbour dues, or port dues, or both, in order to meet the increased liabilities which they propose to incur. Such increase, and more especially under port dues which have just been reduced, is, however, peculiarly feasible, and may possibly not entail more than a temporary increased taxation on the trade. There is also a considerable, though not as yet ascertained, surplus to the credit of the Madras Port Fund, which will now be at the disposal of the Board as Conservator. On the whole, from a financial point of view, the Board's ability to repay the further advance now in question seems sufficiently established.

(7) Of course, if the Board's prayer for a reduction of the interest on capital advances from 4½ to 4 per cent. is complied with, the necessity for imposing fresh rates will be *pro tanto* diminished. The Government, in this department, consider that the request is a reasonable one, and deserves the favorable consideration of the Secretary of State.

(True Extract.)

(Signed) W. L. C. RADDELEY, Capt., R.E.,
Under-Secy. to Govt., P.W.D.,
for Chief Secretary.

G.O., dated 6th March 1888, No. 764 W., Public Works.

Read—the following paper:—

From R. R. BUCKLEY, Esq., 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 Calcutta, 28th February 1888, No. 106 M.

With reference to the Secretary of State's despatches, noted in the margin, on the subject of the best position for the entrance to the Madras harbour, I am directed to forward, for His Excellency the Governor's information, copy of a Note on the subject, by Mr. Molesworth, the Consulting Engineer to the Government of India for State Railways.

Nos. 10 and 11 P.W., dated respectively the 26th November and 15th December 1887, to the address of His Excellency the Governor of Madras.

Enclosure.

Note by G. L. Molesworth, Esq., *Consulting Engineer to the Government of India for State Railways, on the subject of the Madras Harbour.*

The committee, composed of Admiral Sulivan, Sir John Coode, and Sir George Nares, has now pronounced in favour of an entrance at the north-east corner of the Madras harbour, closing the present entrance to the east.

Of the four plans proposed, and marked Nos. I, II, III and IV, respectively, the committee records its preference to No. III on nautical grounds, but it does not state the names of those grounds.

Plan No. I was originally proposed by the Madras committee in its report, dated June 10th, 1887; but when that report was referred to me by the Government of India for opinion, I pointed out in my Note of July 17th, 1887, the very serious objections to which this plan was exposed from its converging curve and from the action of southerly waves.

I also pointed out that plan No. II (which, in my opinion, was the necessary modification of No. I in order to remedy its defects) was open to the undoubted objection of throwing sands, entering the harbour, further into about water than was desirable, and I suggested for consideration the alternative plan of retaining one of the lines so as to cover the existing entrance as shown in No. IV.

In May 1887, Mr. Thorneycroft submitted, for the consideration of the Madras Harbour Trust Board, plans Nos. I, II and IV, and in addition to these plans he also submitted the modification of No. IV, as shown in plan No. III.

In No. III the extension of the face is carried out with a slight change of direction, whereas in the plan I suggested, the extension was in a straight line, on the prolongation of the face.

Mr. Thorneycroft, however, in putting forward plan No. III, accorded the preference to No. IV, which also found most favour with the Harbour Board for the following reasons:—

"(1st) That only a very small portion of the old ruined wall and rubble have to be cleared away.

"(2nd) That during the construction there will never be more openings than the proposed entrance through which the sea can come.

"(3rd) That it allows the work to be proceeded with at present at least for 4 months or more."

I may add that I prefer my original suggestion as it stands in plan No. IV to its modified form as plan No. III, because, in addition to the above-mentioned advantages, No. IV allows more sea room and involves less disturbance at the mouth of the harbour from the action of confluent waves. The relative estimates of plans Nos. III and IV are Rs. 61,00,000 and Rs. 62,45,000, respectively.

The ends of the covering arm should, in my opinion, be turned inwards instead of outwards as shown on the drawings.

If No. III is to be carried out, I would strongly recommend a slight modification of it, as shown by the blue lines which I have drawn in the plan No. III that accompanies the report of the committee.

Order—dated 6th March 1888, No. 764 W., Public Works.

Communicated to the Harbour Trust Board for consideration, in continuation of G.O. No. 404 W., dated 4th February 1888.

(True Extract.)

(Signed) J. O. HASTED, Colonel, R.E.,
Secretary to Govt., P.W.D.

G.O., dated 9th June 1888, No. 1715 W., Public Works.

Read—the following paper:—

From the Secretary to the Government of India, Public Works Department, dated 23rd May 1888, No. 261 M.

In continuation of Public Works Department No. 106 M., dated the 28th February 1888, I am directed to forward, for the information of His Excellency the Governor in Council, the accompanying copy of a further Note, dated the 5th May 1888, by Mr. Molesworth, the Consulting Engineer to the Government of India for State Railways, on the subject of the best position for the entrance to the Madras harbour.

Enclosure.

Note by G. L. Molesworth, Esq., *Consulting Engineer to the Government of India for State Railways, dated 5th May 1888, on the subject of the best position for the entrance to the Madras Harbour.*

When I wrote my last Note on the Madras harbour, I had not seen the minutes of evidence which induced the committee to prefer plan No. III on "nautical grounds." I have now had an opportunity of studying that evidence, and I would suggest, for consideration, a slight modification of the plan I originally suggested (marked No. IV). This modification consists simply in prolonging slightly further the eastern arm which I had suggested; and also slightly altering the tangent point from the north-eastern elbow so as to change its position instead of having it in the position in which it was originally built.

I have shown the prolongation of the eastern arm sufficiently long to cover the opening and project it from west coming in, even at an angle of 30° from the normal direction.

In my report on the Madras harbour, dated March 1st, 1882, para. 90, I advanced the opinion that "the *wave of a dangerous character* most *always come in broadside to the shore* as nearly as whatever the position of the *shore*," and in paras. 75 and 76 of that report, I gave my reasons for the opinion I advanced. This opinion is confirmed by the experience of nautical men, as given in the evidence. The direction of the wave is stated to be quite

independent of the direction of the wind, and that the heavy swells come in nearly broadside to the shore, even when the wind is blowing off the shore. Others state that the direction of the waves never exceeds an angle of 30° from the normal, but I doubt very much whether any waves, except those of oscillation, which are comparatively harmless, can possibly come in at any angle approaching this.

In fact, it is opposed to the laws governing the motion of waves that a wave of translation should deviate to any considerable extent from the parallel of the general direction of the contour lines of the bottom of the sea to seaward of the harbour.

As one entering at an angle of 30° will, however, be on the safe side, as protecting the entrance to the harbour, even from waves of oscillation.

I annex a sketch showing the modifications I would propose to my original suggestion, the existing work being shown in black lines, my suggestion of *July* 1887 in red lines, and the slight modifications I now propose in blue lines.

These modifications will, in my opinion, meet any objections that may be raised on "nautical grounds" to my original suggestions, whilst they will be free from some of the objections to which project No. III is exposed.

Order—dated 9th June 1888, No. 1715 W., Public Works.

Communicated to the Chairman, Harbour Trust Board, for early remarks, in continuation of G.O. No. 764 W., dated 6th March 1888.

(True Extract.)

(Signed) J. O. HASTED, Colonel, R.E.,
Secretary to Govt., P.W.D.

From R. W. BARLOW, Esq., C.S., Chairman, Harbour Trust Board, to the Chief Secretary to Government, Marine Department, dated Madras, 21st June 1888, No. 1008.

I have the honor to acknowledge G.O. No. 1715 W., dated the 9th instant, forwarding, for the remarks of the Board, a note with plan attached by Sir G. Molesworth regarding the best position for a north-east entrance to this harbour. These were, after circulation, very carefully considered at the meeting of the trustees on the 19th instant, and I submit copy of the resolution then passed, together with copy of a letter from the Board's engineer, No. 968, dated 18th idem, replying to a reference made to him on the subject.

2. Sir G. Molesworth's plan, if carried out, would give the harbour a slightly larger area, but this would be of no practical use for the anchorage of vessels; it would also afford additional protection against waves of translation coming in at a maximum angle of 30° from north of the normal direction; but the trustees note that Sir Guilford gives it also as his opinion that "waves of a dangerous character must always come in broadside to the shore, or nearly so," and it is this the trust fully concurs, while they also agree with him that "waves of oscillation" are "comparatively harmless," even should they come in at an angle approaching 30°.

3. The Board consider that they would not be justified in incurring the additional heavy expenditure and delay which the adoption of Sir G. Molesworth's design would involve. The junction of the new curves at the north and south arms with the old works, left undamaged by the cyclone of November 1883, proved a most difficult and costly undertaking, and the trust are not disposed to accept any modification that would involve a repetition of this at the north arm. The revised plan would further necessitate the removal of a considerable portion of the new work at the southern arm at a heavy outlay, protected, as it is, by a 40-foot wave-breaker screen. The proposed alteration would, besides, carry the south arm into deeper water, as pointed out by our engineer involving still further expenditure. Under a review of the above conditions, the Board are decidedly opposed to the modification suggested by Sir G. Molesworth, and adhere to plan III or IV, as already submitted to Government.

Engineers.

From F. N. THOROWGOOD, Esq., M. Inst., C.E., Superintendent, Madras Harbour Works, to the Chairman, Harbour Trust Board, dated Madras, 18th June 1888, No. 968.

I have the honor to return, herewith, the papers which accompanied your letter No. 954, of June 13th, with Sir Guilford Molesworth's modified plan for an entrance to the Madras harbour.

It appears to me that nearly the whole of the outer portion of the north pier will have to be taken up to carry out the design proposed, and the greater depth of water into which the north arm is brought, will undoubtedly add to the cost of the work and increase the time of construction.

Extract of Proceedings of the Trustees of the Harbour of Madras, at a meeting held at the office of the Board, on Tuesday the 19th day of June 1888.

* * * * *

3. Read letter from the Engineer, Harbour Trust Board, No. 968, dated 18th June 1888, submitting report upon the modified plan for an entrance to the Madras harbour, by Sir Guilford Molesworth, communicated with G.O. No. 1715 W., dated 9th June 1888.

Resolved that the additional protection afforded would not justify the increased expenditure and delay which would be incurred by the necessity for taking up a large portion of the new work recently constructed at the head of the north arm.

* * * * *

(True Extract.)

(Signed) C. PINSENT,
Secretary, Harbour Trust Board.

Transferred to the Public Works Department.

(Signed) H. E. STOKES,
Chief Secretary.

Confidential.
22nd June 1888.

Note by the Chief Engineer, Public Works Department.

To a member of the committee appointed in 1883, which first suggested a north-east entrance to the harbour, a perusal of the report of the committee appointed by the Secretary of State to consider the subject, with the interesting notes of evidence, must be satisfactory. It seems now at last to be allowed generally that a north-east entrance is necessary, and it is the opinion of eminent nautical men that steamers can enter and leave the harbour by such an entrance without much difficulty.

2. This opinion was all that was needed by this Government.

3. There seems to be no reason why the Government should not accept, without hesitation, the position of entrance as approved by the Home committee, and generally by the Harbour Trust Board; the only apparent objection to it is that it necessitates the removal of a very considerable extent of old work which would have been avoided by the adoption of either plan No. 1 (originally proposed) or plan No. 2. It has, however, the advantage of opening in deeper water rather further from the shore and this may be worth the extra cost.

4. There is, however, another plan very recently submitted by Sir G. Molesworth, which was not before the Home committee, and which, coming from such an authority, deserves consideration. This plan is a considerable modification of one formerly submitted by Sir G. Molesworth, as it provides, by an altered form of the arms, for completely sheltering the entrance from waves approaching the coast from any possible direction north of the normal, which his former plan did not. It would, moreover, increase the accommodation within the harbour, and would bring the entrance further from shore than the plan approved by the Home committee. In all respects, therefore, the proposal is a good one; but we have no estimate of its cost, and it is evident from the length of the arms and the depth of water in which they are to be constructed that it must much exceed that of the proposal by the Home committee,

while it would seem that at least as much old work has to be removed in one case as in the other. The Harbour Trust Board are opposed to the scheme (see their letter, No. 1986, dated 21st June 1888).

It is right that Sir G. Molesworth's note and proposal should be laid before the Secretary of State, but it seems to be questionable whether the advantages which it secures are sufficient to warrant additional outlay and consequent delay in completion of the harbour.

5. In his remarks on the report of the Home committee, Mr. Parkes enters very fully into the subject of the advance of sand on the works which the evidence before the committee led them to suppose was a very serious matter, and which they adduced as one reason for their preference for a north-east entrance. The Harbour Trust Board briefly dispose of this subject, considering that it is a matter of no present practical importance, and that had the committee been in possession of information which Mr. Parkes states he received after the sittings of the committee, they would probably never have alluded to the subject. The committee apparently had before them surveys of the harbour up to 1887, and from the soundings in 1886 came to the conclusion that the sand was advancing south of the works faster than was anticipated. Mr. Parkes maintained that the apparent advance in 1886 was due to the heavy cyclone we in May 1886, and would not be found to be a real advance; the information which he received after the committee ceased their sittings was from a survey made in September 1887, and which showed that the actual advance during the year near the works was considerably less than that anticipated by the committee. This certainly strengthens Mr. Parkes's position, and the result of examination, made at different times, of the soundings leads to the conclusion that the advance of sand need not be considered as such a serious matter as the committee think. The committee considers the sand will have advanced to the end of the south arm in twenty years. Mr. Parkes says 50 or 60 years, but he calls attention to another point; he says, "I contend that it is now well established how the sand comes, and in what quantities it comes, and therefore how it may be intercepted when it becomes necessary, and what the cost of intercepting it will be. It may be added that that cost, which will not be required for 50 years, will not therefore be a serious burden on the trade." It is submitted that Mr. Parkes's views on the question are sound, and that the advance of sand is not a matter for present consideration.

6. Mr. Parkes's views as to the question of a north-east entrance are not definitely stated in his remarks on the committee's report. He refers to the conflict of opinion between the two committees appointed by the Secretary of State, and apparently considers the question to be still unsettled. He doubts whether the present strong feeling in favor of the north-east entrance will be permanent at Madras, and suggests that Captain Taylor's successor may hold different views, that the Harbour Trust Board is a changing body, and that the financial view of the question may alter the present opinion. To this it may be replied that from June 1883, when the committee appointed in Madras proposed the north-east entrance, all authorities in Madras have persistently advocated the north-east entrance; the Harbour Trust Board, from the date of their constitution, were strongly in favor of it, and as at present constituted, with the successor of the late Captain Taylor as member, have expressed themselves more strongly than ever in favor of it, and the financial position has been carefully estimated by the Board and reviewed by Government in G.O. No. 151, Marine, dated 25th April 1888. The Government have always been in favor of the north-east entrance, while allowing that the question was one on which nautical opinion deserved the highest consideration, and now that a committee of eminent naval and engineering authorities, selected by the Secretary of State, have reported in favor of it, it is considered that the question should be finally disposed of and the north-east entrance adopted.

7. Considering, therefore, the question settled and the form of entrance suggested by the Home committee adopted, it remains to be decided how the work is to be carried out, and on this point the Board has little to say. Mr. Parkes is evidently in favor of proceeding on the mentioned plan till such pier is built to within about

500 feet of its termination; in fact, almost completing the harbour on the present sanctioned design, and then removing part of the work to form a north-east entrance. He suggests that the question of a change of entrance might then be reconsidered, but following what has been said above, the suggestion should be rejected. He says, "To carry out the work to that extent would take about eighteen months, during every month of which time the shelter would be improving. To proceed on the plan recommended by the committee, the first two or three years would be spent in opening the harbour still more to the sea, and that in the most dangerous possible form, while a further three years would be occupied before anything like efficient shelter would be obtained." This may be true, but it has to be remarked that the work to be removed to form a north-east entrance at present is much shattered and comparatively easy of removal, while if the harbour is nearly completed on the present design, the work to be removed will be the strongest part, most carefully fitted together, and the difficulty of removing it may then be considered too serious to be overcome. In either case special machinery will probably have to be procured for the removal of the old work, and we ought to have careful estimates of what the cost would be in both cases. It may possibly prove, as the best way of completing the harbour expeditiously, that the northern arm should be nearly completed on the line of the present design, so that one crane could be used in erecting the protecting arm of the committee's approved plan, while another is pushing on the southern arm, but it can hardly be the most economical plan, and it should be considered, if this method of working is be adopted, whether the section of the work, which would only have to stand for a year or two, should not be modified with a view to the easy removal of the blocks as soon as the protecting arm is completed. The most economical method of working would, it is believed, be to clear the north-east entrance as expeditiously as possible, and then close the existing entrance and run on the protecting arm, for which a very large amount of material would be in readiness. The harbour would be more exposed than it is at present for the time, but probably even then it would only be for a few days in the north-east monsoon that the sea inside would be too rough for work; during the south-west monsoon it would be quite sheltered.

8. If the question of a north-east entrance is now definitely settled, this question of how the revised plan is to be carried out will be of the first importance. The Board might, it is suggested, be asked to prepare detailed estimates of the cost of removing the old work, and to state their views on the subject of opening the north-east entrance at once, in order that there should be no delay in proceeding with the work on receipt of approval of the Secretary of State to a change in design.

(Signed) J. O. HASTED, Colonel, R.E.,
Chief Engineer, P.W.D.

Bangalore,
27th June 1888.

Order—dated 1st August 1888, No. 2335 W., Public Works.

In accordance with the earnest request of the Government, in their letter No. 1457 W., dated 9th June 1884, to the Secretary to the Government of India that the question of a north-east entrance to the harbour should be referred to more competent nautical authority, the Right Honorable the Secretary of State appointed a committee composed of Admirals Salmon and Nares and Sir J. Coode, to report on the subject.

2. The Governor in Council has read with much interest the committee's report and the voluminous notes of evidence taken by them, and is gratified to learn that the committee shares the views held by this Government as well as by all competent authority in the Presidency, and is in favor of an entrance at the north-east corner of the harbour, with a covering arm. An entrance at this corner would possess the additional advantage of being fully protected against naval attack by the shore batteries, which it is proposed to construct to the north of the harbour; but an entrance in the centre of the eastern arm can receive but little protection from shore

batteries, and that arm would, within a certain distance, afford cover to boats attempting to form an entrance for the purpose of destroying the shipping in the harbour.

3. The plan proposed by the committee has been generally approved by the Harbour Trust Board and by the Chief Engineer, and is accepted by the Government.

4. The Harbour Trust Board will be requested to submit their views as to the best method of carrying out this plan with an estimate of the cost, and of any further machinery that may be required, and the Secretary of State will be asked to communicate by wire his sanction to the prosecution of the work on the committee's design.

Ordered that the Secretary of State be addressed.

(Here enter No. 2335 W. dated 1st August 1868.)

(True Extract.)

(Signed) J. O. HASTED, Colonel, R.E.,
Secretary to Govt., P.W.D.

To the Chairman, Madras Harbour Trust Board.
Marine Department.

Endorsement—dated 1st August 1868, No. 2336 W., Public Works.

Copy of the above, with copy of the despatch to the Secretary of State, forwarded for the information of the Government of India.

(Signed) J. O. HASTED, Colonel, R.E.,
Secretary to Govt., P.W.D.

Enl. F. A. Bentinck,
Typo. Gloom

1868
193

Con 4761

To Govt

This file cannot
have objection, but
leave to W. for orders
with reference to Engr's
a despatch to the Secy
of State

The further letter
was under objection
for reference for
a despatch

The further letter
has been delayed a day
or two in consequence
of some of the letters
not orders with being
received by overland mail

Con
17.7.69

The Secretary file to Mr
was sent on furnished.

Letter Dated 7 & 8 August received
letter file please Opinion of the
Secretary, and of Superintending Engineer
with Chief Engineer, and Chief

106
122

Circ 4361

To Dr

This file must
now apparently be
sent to Mr. for views
with respect to Right
a distribution of the Song
Sylvia.

The further hearing
was also apparently
for reference for
a decision.

The file has
been delayed a day
or two in consequence
of some of the Solicitors
note orders not being
readily available

Circ
15.5.39

Mr. Dent the file to Mr
as soon as possible.
Letter No 69 of 6th April 1939
written to the Public Trustee of the
Transvaal, and of Government Agent
at Natal Pietermaritzburg

IV

I see that I was
mistaken in supposing
that Mr Parkes' plans
contained a proposal
for a tank house. I
remember now that
it was Mr Thompson
who suggested the tank
house, as an addition
to Mr Parkes' design.
The question of a tank
house does not
enter into the question
you ask Mr Parkes, as regards
I proceed on the basis laid
down for the pumping work,
and also the Contract value
after the N.E. opening has
been made by pitching
up enough of the N wall
to give 500' square opening.
But in my opinion a tank
plan the Trust ought to
have adopted, but I think
market not open in the war.

Yours
H. S. W

1893

The Number of the Remarks
appended in 1883 shall not
exceed a N.I Number between
the Number of the
Remarks appended by the
Ct of Rts to consider the Report
& the whole No of
Lessons shall be distributed
to some one of each Class
shall [illegible] but a
N.I Lesson is appointed
to 3 Ch Classes of Lessons
Marked non-Ch Standard
on which a Lesson shall be taken
by each Ch Lesson which
shall alternately
2. This opinion was not sent
marked by the Ps
3. If in the
Lessons to which the
Ps shall not consider the
of Lessons as required by the
New Code is passed by
the Ps shall be only
Optional
A Special Lesson not in list of
Lessons to be used of a very
inferior kind of work but
which shall be considered
by the Ps of the Standard
Compulsory passed of the Ps

The Number of the Committee appointed in 1883 which first explored a N.S. Northern Railway

~~106~~ 192

106
122

had the Drawings back of the
note from Mr Wm which that
Mr Peter mentioned that he
expected down in 1755 and he
at long by the Dec in May 1756
a week or so past the a week
down. Mr Symonds should be
warned that the Mr Wm should
Mr Peter who from a long visit
in Sept 1757 as this should be
Mr Wm Down. Mr Wm to write
the Architect as to the Mr Wm
appointed by the Architect. This
being together Mr Peter's visit
& the result of the visit should
have with Mr Wm from the
Drawings with the Architect
that the Drawings of the Mr Wm
Mr Peter's visit to be
to pass. Mr Peter says so on
to pass, but he adds whether
& which Mr Wm; he says "I wished
Mr Wm is not able whether with
Mr Wm and Mr Wm is that
Mr Wm Mr Wm, Mr Wm
Mr Wm by Mr Wm Mr Wm when
Mr Wm Mr Wm, and that
Mr Wm Mr Wm Mr Wm Mr Wm
Mr Wm Mr Wm Mr Wm Mr Wm
Mr Wm Mr Wm Mr Wm Mr Wm
Mr Wm Mr Wm Mr Wm Mr Wm

Feb 1932

5

have expressed themselves more strongly than ever in favour of it, and the principal benefits we have hitherto derived by the Board's control by Act of Parl. [illegible] 57th Geo. III. The Act has always been in favour of the N.S. interest, this clearly but the practice under which Merchant ships obtained the highest encouragement, and, we trust, a continuance of similar reward and legislative attention will establish further benefits to the Port, if it is considered that the practice should be strictly limited to the N.S. interest employed.

7. Avoiding Ships to the Port which in the form of Steam Vessels might be adopted, it seems the desired object that the work in the channel will, in the first instance, be done with the [illegible] Act. Parties in favour of steering into channels where [illegible] to such time as [illegible] of which also Steamers of the [illegible] in fact, almost completely the Harbour in the present channel which [illegible] Ships [illegible] the work from a N.S. interest - the object that the

Question of a change of Cultivation
might well be considered, but
perhaps what has been said above
has superseded what is required.
The Engineer should be consulted.
Lays "Do they not the work which
should take place before
Irrigation, during Course much of which
like the Weather would be in during
the period when determination
Cultivation Commences, the first Crop
which Seems would be effected" a change
of Cultivation also would be, which
as the most dangerous hazards from
which a fruitful Year Seems would be
anticipated before any step like Effected
Weather would be obtained
This may be true, but it has also
been said that the Ground
by from a N.E. Climate of Frost
is much Ameliorated & Improved by
a Winter's Exposure to the Weather &
Cultivation which if the Weather is
Favourable with Frost Snow, &
will the Ground rise in the
Spring Heart, more mellow pulverised
Lighter, & the Necessity of Burning it
may Not be considered as Being
that the Weather. If which Ever
should Happen will probably Save
the Ground for the Season of the
Year with a Crop Plow Cultivation
Better than if other Crop had been
in & Cut Down. It may Possibly
Even, be the best way of Cultivating
the Ground Expeditiously, that

122

1947
116

Form.

1/22

D.J.

Proof of Mrs. Whitty's
description of entrance
of the Barbican, submitted
for inspection.

I have gone through
the proof & find
that the alterations
have been correctly
inserted. Yours

S.W.V.

We wish that the proof of the Madras Harbour reconstruction papers forwarded herewith, should be submitted to S.W. for approval before the matter is struck off.

The papers are of course to be printed speedily.

A.S.
11-VII-96

Press
13.7.96

135 114

1883
No 93

To Lord Ripon

1883

1. Sir Lees has been in communication
with the Lord Lieutenant
of
with respect to the Commission appointed
by the Lord Lieutenant to enquire
into certain matters connected with
Murders and Acts of violence,
and directed by Mr Parnell

2. Sir Lees communicated with Mr Redmond
Mr Parnell Mr Dillon Mr Brennan & Mr
Mr Sexton & Mr Healy for the
Lord Lieutenant's Order of the
Secretary State

3. Sir Lees subsequently communicated with
Mr Parnell Mr Dillon Mr Brennan
and Mr Healy & Mr Sexton & Mr Healy
Mr Redmond & Mr Parnell

BUILDINGS AND ROADS.
CIVIL WORKS.

Govt. of {1888} Madras.

PUBLIC WORKS.

Dated August, 1st.

Recd. *Encl.*

G.O., 1st Aug. 1888, Nos. 2335, 2336 W.

AUGUST.

Madras Harbour

Forwarding copy of Proceedings on the report of the Home committee regarding the best position for an entrance to the Madras Harbour; and requesting early intimation of the final adoption of the committee's plan.

PUBLIC WORKS DEPARTMENT.

Letter—to

The Right Honorable the SECRETARY of STATE for INDIA.

My Lord,

We have the honor to acknowledge receipt of Your Lordship's despatches, No. 6, Public Works, dated 6th May 1887; No. 10, Public Works, dated 24th November 1887; and No. 11, Public Works, dated 15th December 1887, respectively, with report of the committee appointed by Your Lordship to consider the best position for the entrance to the Madras Harbour and notes of evidence; and remarks by Mr. Parkes thereon.

2. We have communicated these papers to the Harbour Trust Board, and have now the honor to forward, for Your Lordship's perusal, copy of our Proceedings No. 2335 W., dated 1st August 1888, embodying a report by the Board and a Note by the Chief Engineer, Public Works Department.

3. We have carefully considered all that has been written on the subject, and are prepared to accept the plan proposed by the committee, which we consider will best meet all requirements. We would, however, call Your Lordship's attention to a plan* recently proposed by Sir G. Molesworth, which would also, we think, meet all requirements, and possesses some advantages which the committee's plan does not, but which would, we consider, prove more costly.

* *See* letter from Chairman, Harbour Trust Board, No. 1086, dated 21st June 1888.

4. We shall await intimation from Your Lordship that the plan proposed by the committee has been finally adopted, but we have the honor to request that this may be made by telegraph. Meanwhile, we have called on the Harbour Trust Board for an expression of their views as to the best means of carrying out the proposed plan and for a detailed estimate of the cost. We are fully impressed with the necessity for adopting an expeditious method of carrying out the works to completion, but we are not convinced that Mr. Parkes's proposal to nearly complete the work on the existing sanctioned plan before clearing the north-east entrance will prove economical or satisfactory.

5. We have the honor to solicit Your Lordship's favorable consideration of the Board's request that the rate of interest upon capital advances may be reduced from $4\frac{1}{2}$ to 4 per cent. per annum, which appears to us reasonable. With reference to the

concluding paragraphs of the Chairman's letter No. 69, dated 6th April 1888, we have communicated to the Harbour Trust Board Your Lordship's despatch dated 7th June 1888, No. 4.

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

(Signed) CONNEMARA.
(„) C. G. ARBUTHNOT.
(„) P. P. HUTCHINS.
(„) H. E. STOKES.

Ootacamund,
1st August 1888.

Ext. F. R. Bantleman.

GOVERNMENT OF MADRAS.

MARINE DEPARTMENT.

READ—the following paper :—

From R. W. BARLOW, Esq., C.S., Chairman, Harbour Trust Board, Madras, to the Chief Secretary to Government, dated Madras, 6th April 1888, No. 69.

I have the honor to acknowledge the receipt of G.O., No. 153 W., dated 16th January 1888, forwarding a letter from Mr. Parkes addressed to the Under Secretary of State for India, dated 25th November 1887, and to submit, for the information of Government, an extract of the Proceedings of the Harbour Trust Board at their meeting of 2nd March, confirmed at the meeting of the 8th idem.

2. The question of the position of the entrance has been most carefully considered and very fully discussed ; and while the trustees "adhere to their former resolution as to the necessity of a north-east entrance, and (with one dissentient) prefer plan, No. III, approved by the London Committee, subject to any modifications that may be proved necessary hereafter," they are unanimously of opinion that *smooth* water is absolutely necessary to make the harbour a success, as without it very little practical progress can be made, in the improvement of means for conducting landing and shipping operations, inasmuch as with an eastern entrance all improvements effected, in the way of providing large iron lighters, low level wharfage, &c., are liable to be wrecked by the free entrance of the heavy rollers accompanying each succeeding cyclone, or very heavy weather.

3. The Board do not think the harbour can be looked upon as a harbour of refuge from a cyclone, until experience has proved it such ; and, at present, are of opinion that no ship would attempt to enter the harbour for shelter, or if inside remain, on the approach of, or during a cyclone, if it should be at all practicable to put to sea beforehand ; that, during the prevalence of such a storm, it may be taken for granted all shipping operations would be suspended, and that on its approach all vessels would put to sea, and return when the weather had moderated.

4. It is absolutely essential, in the opinion of the trust, to the future prosperity of this port, that ships so returning should find lighters and machinery, for loading or landing cargo, ready to go to work at once ; and lighters and jetties, with cranes erected thereon, must depend for safety upon the smothness of the water in the harbour. An eastern entrance will never give *smooth* water during at all heavy weather, and though a boat harbour, as proposed by Mr. Parkes, would secure the lighters, it would leave jetties and wharves, in the harbour, with the cranes thereon unprotected, and exposed to certain destruction.

5. Referring to the three points dealt with by Mr. Parkes in his letter, the trustees would remark with regard (*a*) to the question of the advance of the sand to the south of the harbour, that had the committee been in possession of the information referred to by Mr. Parkes in paragraph 22, they would probably never have alluded to the subject. The advance of sand to the south of the southern arm of the harbour is, the Board consider, a matter of no present practical importance, and has nothing whatever to do with the question, whether the best position for the entrance is east or north-east.

6. In reference (*b*) to the second point raised by Mr. Parkes, the Board unanimously approve the decision of Admirals Salmon and Nares and of Sir John Coode, and, as there are "two co-existing but conflicting judgments based upon the same evidence," would strongly urge their right to act upon the one which coincides with

their own unanimous views. It is in their opinion a most difficult task for gentlemen at a distance, who may never have seen this port in a cyclone, and are totally unacquainted with its business, routine and requirements, to form a judgment. The Board would most emphatically urge that they are in every way best qualified to know what is wanted, altogether independent of a mass of conflicting testimony, which is all the gentlemen forming the various committees at a distance have to guide them.

7. Referring (*c*) to Mr. Parkes' third point, the Board agree with him in paragraph 29 that he had perhaps "rather enhanced than otherwise the difficulties of the situation"; they *favor* plan No. III, but what they *want is smooth water*, ensuring safety to landing and shipping appliances in heavy weather. Any modification of plan III or IV or any plan which will give them *this*, within a reasonable time, at a cost which this port can afford to pay, to all they have contended for as being absolutely necessary, and upon the absolute necessity of *smooth water* they do most strongly insist.

8. The Board do not approve of Mr. Parkes' modification "A" which presents the objectionable re-entering curve to the full force of a cyclone swell, immediately to seaward of a proposed entrance, and they understand that this is one objection previously insisted upon by all Engineers who have been consulted.

9. The question of an alternative scheme brings me to the financial position and revised estimates.

10. Mr. Parkes estimates the extra cost of his new proposal, above sanctioned estimate, with 600 feet overlap, at Rs. 18½ lakhs, and with 800 feet, Rs. 21¼ lakhs (paragraph 32).

On referring the question to their Engineer, Mr. Throwgood, he estimates the probable extra cost *for Mr. Parkes' Plan A*, at Rs. 24,75,976 and Rs. 27,14,230, respectively.

11. *For Plan III*, Mr. Throwgood estimates the extra cost to be Rs. 27,79,105 and Rs. 30,05,363 for 600 and 800 feet overlap, respectively.

12. In estimating their financial position the trustees prefer to take their own Engineer's estimate, made on the spot, and, in round figures, the result would be as follows, upon the date when it is anticipated that the works will be complete:—

600 feet Overlap.

	Rs.
Sanctioned estimate	46,55,000
Add extra for plan III	27,70,000
	74,25,000
Deduct—	
Advances refunded—	
1886-87, 1887-88	2
1889, 1894	6
	8,00,000
Capital advances outstanding, 1894-95	66,25,000
Interest thereon @ 4¼ per cent	2,96,125*
Annual refund of loan	1,00,000
Amount payable to Government	3,96,125
Income—	
Revenue account	
Port dues levied under Acts XII of 1873 and IV of 1881	3,00,000
Surplus of pilotage fees	1,20,000
Warehouse charges	12,000
	20,000
	4,52,000
Deduct amount payable to Government as above	3,96,000
Balance to credit of trust	54,000

* Decreasing annually by Rs. 4,500, the interest at 4½ per cent. upon one lakh of rupees.

800 feet Overlap.

	Rs.
Sanctioned estimate	46,55,000
Add, extra for plan III	30,08,000
	76,63,000
Deduct—	
Advances refunded as above	8,00,000
Capital advances outstanding, 1894-95	68,63,000
Interest thereon @ 4¼ per cent	3,08,800*
Sinking fund	1,00,000
	4,08,800
Income as above	4,52,000
Balance to credit of the trust	43,200

* Decreasing annually by Rs. 4,500, the interest at 4½ per cent. upon one lakh of rupees.

13. In framing the above estimate the calculations have been based on actuals of previous years; the revenue from port dues is shown at Rs. 1,20,000 only, that being the amount shown in paragraph 11 of G.O., No. 15, dated 17th January 1888, after allowing for the reduction of Annas 1-6 per ton on liners, recommended by the Board in my letter, No. 6974, dated 5th March 1888. The surplus of pilotage fees is taken from the actuals of 1886-87, Rs. 12,467. With regard to the item, Rs. 20,000, warehouse charges, the Board propose to supply, as soon as possible, a want very much felt in Madras, by erecting warehouses, and storing goods therein under warrant, in the same manner as is done in Bombay, where the Port Trust received in 1880-81, when the system was first introduced, *Rs. 30,716-5-1*, which in 1884-85 had risen to Rs. 97,280-15-3, or deducting cooly hire, to about Rs. 85,000 net. The Board are of opinion that at least Rs. 20,000 might be raised from this source increasing annually.

14. Another source from which a large income might be derived is by saving in *boat hire*, provided smooth water can be relied on in the harbour; this is now fully Re. 1 per ton all round, the total tonnage handled yearly being between 2½ and 3 lakhs of tons. Taking the lower figure, to allow for timber floated on shore, and calculating a saving of 12 annas per ton in boat hire charges as practicable with smooth water, an additional revenue of Rs. 1,87,000 could be levied, as enhanced harbour dues, without imposing any additional tax on the trade of the port; and this sum, with the surplus shown above, is more than sufficient to meet all current charges, including petty construction. The reason why boat hire is so excessively high at Madras is the insecurity of the investment in lighters, which are liable to be smashed to pieces at any moment, and which, under ordinary circumstances, soon become unserviceable, through constantly beating up against each other, against ships' sides, and against the piles of the pier. Iron lighters carrying 100 tons each could, with smooth water, be safely maintained in the harbour, and loaded beforehand against the arrival of a steamer, thereby economising time. A charge for boat hire of only 4 annas a ton, yielding Rs. 25 per trip, would be, if anything, too high, and more than would be needed to pay a handsome return upon a comparatively secure investment. But the Board do not wish, if it can be avoided, to enhance harbour dues, when smooth water renders a reduction in boat hire practicable, one of the chief objects of the harbour being not only to facilitate but to cheapen landing and shipping operations, and they would prefer to allow the trade of the port to benefit, as much as circumstances will permit, by any reduction which may be found practicable hereafter. It would probably be sufficient at first to divide the saving effected between the Board and the merchants concerned.

15. I am further requested by the Board to ask that Government will suggest to the Right Honorable the Secretary of State that the rate of interest upon capital advances might be reduced from 4½ to 4 per cent. per annum, which would be of material assistance to the trade of the port.

16. In conclusion, I am desired, by the Board, to urge upon Government that the Board consider that Mr. Parkes is not sufficiently acquainted with this port to enable him to form a correct opinion of its requirements, and the result of carrying his theories into practice has already been far from satisfactory.

17. The Board have on the spot a staff of Engineers who for many years have had the advantage of an intimate practical acquaintance with the harbour which, in its present condition, admits of completion within only very narrow limits of design, and the Board would earnestly represent that all details, in reference thereto, should be settled on the spot, by themselves, subject to the control of the Madras Government, who can instruct their Engineers to inquire into and examine any deviation from the sanctioned plan which it might be considered in the interests of the port to adopt. This would obviate the delays which have occurred hitherto through constant references to England.

18. The Board are quite willing to subordinate their wishes to engineering control, but would most strongly urge that this control should be in the hands of the Madras Government, and if any proposals which might be made were approved by Government, the Board respectfully submit that the Right Honorable the Secretary of State might rest assured that the matter had been carefully inquired into by competent engineering authority.

Enclosures.

Extract of Proceedings of the Trustees of the Harbour of Madras, at a meeting held at the offices of the Board on Friday the 2nd day of March 1888.

* * * *

2. Read again all papers in connection with the question of the position of the entrance to the harbour, and minutes by the Chairman, Messrs. C. L. Chambers, J. R. Hunter, Captain W. L. C. Baddeley, R.E., Captain H. A. Street and Mr. J. McLintock, and examined plans in reference thereto. Mr. Thorowgood was asked to attend, and explained to the trustees various points upon which they desired information and then withdrew.

Resolved, that the trust adhere to their former resolution as to the necessity of a north-east entrance and prefer the plan No. III approved of by the London Committee subject to any modifications that may be proved necessary hereafter. The Chairman is invited to submit to Government the views of the Board in regard to the despatch from the Secretary of State, dated India Office, 15th December 1888, communicated under endorsement order No. 153 W., dated 16th January 1888.

* * * *

Extract of Proceedings of the Trustees of the Harbour of Madras, at a meeting held at the offices of the Board on Friday the 23rd day of March 1888.

* * * *

2. Read draft letter from the Chairman, Harbour Trust Board, addressed to the Chief Secretary to Government, Marine Department, in reply to G.O., No. 153 W., dated 16th January 1888, communicating a despatch from the Right Honorable the Secretary of State, No 11, dated 15th December 1887, forwarding a letter from Mr. Parkes, dated 25th November 1887, in reference to the question of the position of the entrance to the harbour.

Read minutes by Captain Street, Indian Marine, Captain W. L C Baddeley, R.E., Mr. Hunter, Mr. Chambers and the Chairman.

Resolved, that this letter, as now amended, be redrafted and circulated for further consideration.

* * * *

Extract of Proceedings of the Trustees of the Harbour of Madras, at a meeting held at the offices of the Board on Thursday the 29th day of March 1888.

* * * *

2. Read again drafted letter addressed to the Chief Secretary to Government, Marine Department, in reply to G.O., No. 153 W., dated 16th January 1888, communicating a despatch from the Right Honorable the Secretary of State, No. 11, dated 15th December 1887, forwarding

a letter from Mr. Parkes, dated 25th November 1887, in reference to the question of the position of the entrance to the harbour.

Resolved, that this letter, as now amended, be approved.

* * * *

Order—dated 25th April 1888, No. 151, Marine.

Transferred to the Public Works Department with the following remarks:—

(1) According to the budget of the current year, reviewed in G.O., dated 7th March 1888, No. 215, Financial, the Board's total revenue receipts, amount to Rs. 3,03,000. But this sum includes Rs. 20,000, interest on investments, which will probably have disappeared before the completion of the harbour, as the current revenue expenditure is at present considerably in excess of the receipts * Again, the establishment and contingency charges amount, in round numbers, to Rs. 1,14,000, and the normal charges for petty construction and repair cannot be taken as less than Rs. 40,000 annually. (The amount provided under this head in the present year's budget is Rs. 95,000). The Board's surplus under Harbour revenue in years to come cannot therefore, on the present sources of income, be estimated at more than Rs. 1,29,000 (Rs. 2,83,000—Rs. 1,54,000) per annum.

Revenue Account.

	Rs.
* Budget estimate for 1888-89—	
Receipts	3,03,000
Charges	4,13,000

(2) The Board have now been appointed conservators of the port under section 8, Act XII of 1875, and this will enable them to apply the surplus port revenues under that Act to the improvement of the harbour. But it must be remembered that the Government can at any time by an executive order remove them from this position.

(3) Even assuming, however, that their position as conservators will be a permanent one, they have largely over-estimated their surplus from port dues, which they put down at Rs. 1,20,000 per annum. The total receipts of the Madras Port in 1886-87, inclusive of pilotage fees, amounted, according to the Port Officer's administration report for that year, to Rs. 1,85,527, while the charges aggregated Rs. 1,45,601. The Board will doubtless be able to effect a considerable reduction in the port establishment, and the revision of port fund accounts ordered in G.O., 17th January 1888, No. 15, will probably be favorable to Madras. But on the other hand the port dues on sea-going ships other than coasting steamers have just been reduced from 6 to 4½ annas a ton, and the Board estimate that this will reduce the receipts under this head by some Rs. 25,000. Allowing for all these changes, the port surplus available for harbour purposes cannot be reckoned at more than Rs. 40,000 per annum in addition to the Rs. 12,000 which the Board have taken credit for under Pilotage fees.

(4) The total surplus upon which the Board can now reckon will therefore be—

	Rs.
From Harbour revenue account	1,29,000
„ Port Fund	40,000
„ Pilotage fees	12,000
„ Warehouse fees	20,000
Total ..	2,01,000

or in all about 2 lakhs of rupees, to meet payments to Government which will amount to Rs. 3,98,000 if the 600 feet overlap is adopted, or Rs. 4,08,000 upon the 800 feet overlap, leaving a deficit of Rs. 1,97,000, or Rs. 2,07,000.

(5) The Board, however, consider that the saving in boat hire will enable the trade to pay increased harbour dues without additional burthen and hope to realise not less than Rs. 1,87,000 per annum under this head. That amount will more than cover the ordinary charges of the Harbour Trust Board which have been omitted in the Board's calculations, but are included above, and will nearly meet the deficit above

shown. The balance remaining may jointly be met by additional warehouse fees, of which the Board have adopted a minimum estimate; or must be provided for by increasing harbour or port dues beyond the amount of the estimated saving in boat hire. The Government are at present unable to test the correctness of these estimates, but they note that the anticipated saving in boat hire depends on the certainty of smooth water, and this cannot be secured until the harbour approaches completion.

(6) It is evident then that, making full allowance for the fact that the interest on the accumulated sinking fund will, as time goes on, materially diminish the net charges, the Board will sooner or later be obliged to raise the harbour dues, or port dues, or both, in order to meet the increased liabilities which they propose to incur. Such increase, and more especially under port dues which have just been reduced, is, however, perfectly feasible, and may possibly not entail more than a temporary increased burthen on the trade. There is also a considerable, though not as yet ascertained, surplus to the credit of the Madras Port Fund, which will now be at the disposal of the Board as Conservator. On the whole, from a financial point of view, the Board's ability to repay the further advance now in question seems sufficiently established.

(7) Of course, if the Board's prayer for a reduction of the interest on capital advances from 4½ to 4 per cent. is complied with, the necessity for imposing fresh rates will be *pro tanto* diminished. The Government, in this department, consider that the request is a reasonable one and deserves the favorable consideration of the Secretary of State.

(True Extract.) W. A. Bouddens

[illegible] Secy.

To the Public Works Department.
- Chairman, Harbour Trust Board.
- Financial Department.

Ed. A. Aubert,

13.8.86

132

No 764 w a/6-3-88.
" 404 w a/4-2-88
" 153 w a/16-1-88.
" 3484 w a/10-12-87
" 2978 w a/7-11-87
" 1895 w a/14-7-87
" 1765 w a/1-7-87
" 1590 w a/14-6-87
" 284 w a/24-1-88.

P.W.C. 4381

Gobt. of {1888} Madras.

MARINE.

Issued

Recd. 11-5-88 Encl.

G.O., 25th April 1888, No. 151.

APRIL.

Madras Harbour.

Passing orders on Harbour Trust Board's proposals regarding additional expenditure involved by change of entrance to the —.

0/15/5 Bds 93-V 9-73-7-88

All communications should be addressed to the Secretary.

No. 106 M

GOVERNMENT OF INDIA.

PUBLIC WORKS DEPARTMENT.

CIVIL WORKS.

Miscellaneous

To

The Secretary to the Government of Madras

Public Works Department.

Calcutta the 28 February 1888

Sir,

With reference to the Secretary of State's despatches noted in the margin, on the subject of the best position for the entrance to the Madras Harbour, I am directed to forward for His Excellency the Governor's information copy of a note on the subject by Mr. Molesworth, the Consulting Engineer to the Government of India for State Railways.

I have the honour to be,
Sir,
Your most obedient Servant
W. B. Buckley

for 1871 & P. dated respectively the 24 November and 18 December 1887 to the address of His Excellency the Governor of Madras

07
88

Do Comments accompanying Copy of Note referred to with plan.

Under Secy to the Govt of India

with 7th of

No. 404 W 4-2-88
- 153 W - 16-1-88
- 3484 W - 20-12-87

P.W.C. No. 214

Letter from P.P. Hinchcliffe Esq

4-2-88

No 764 WA/6 6th March 88 with 20 s.e

4.2.88

Communicated to the Harbour Trust Board for consideration, in continuation of G.O. 404 W dated 4th February 1888.

5.3.88

5/3/88

The Chairman H.T. Board
with 2 enclos:

5/3

Note by G. L. MOLESWORTH, Esq., *Consulting Engineer to the Government of India for State Railways, on the subject of the Madras Harbour.*

The Committee, composed of Admiral Salmon, Sir John Coode, and Sir George Nares, has now pronounced in favour of an entrance at the north-east corner of the Madras Harbour, closing the present entrance to the east.

Of the four plans proposed and marked, Nos. I, II, III and IV, respectively, the Committee accords its preference to No. III on nautical grounds, but it does not state the nature of those grounds.

Plan No. I was originally proposed by the Madras Committee in its report dated June 20th, 1883; but when that report was referred to me by the Government of India for opinion, I pointed out in my note of July 17th, 1883, the very serious objections to which this plan was exposed, from its re-entering curve and from the action of confluent waves.

I also pointed out that plan No. 2 (which in my opinion was the necessary modification of No. 1 in order to remedy its defects) was open to the undoubted objection of throwing vessels, entering the harbour, further into shoal water than was desirable, and I suggested for consideration the alternative plan of extending one of the faces so as to cover the existing entrance as shown in No. IV.

In May 1887, Mr. Thorowgood submitted, for the consideration of the Madras Harbour Trust Board, plans Nos. I, II and IV, and in addition to these plans he also submitted the modification of No. IV, as shown in plan No. III.

In No. III the extension of the face is carried out with a slight change of direction, whereas, in the plan I suggested, the extension was in a straight line, on the prolongation of the face.

Mr. Thorowgood, however, in putting forward plan No. III, accorded the preference to No. IV, which also found most favour with the Harbour Board for the following reasons :—

"*1st.*—That only a very small portion of the old ruined wall and rubble have to be cleared away.

"*2nd.*—That during the construction there will never be more openings than the proposed entrance through which the sea can come.

"*3rd.*—That it allows the work to be proceeded with at present at least for 4 months or more."

I may add that I prefer my original suggestion as it stands in plan No. IV to its modified form as plan No. III, because, in addition to the above-mentioned advantages, No. IV allows more sea room and involves less disturbance at the mouth of the Harbour from the action of confluent waves. The relative estimates of plans Nos. III and IV are Rs. 61,00,000 and Rs. 62,45,000, respectively.

The ends of the covering arm should, in my opinion, be turned inwards instead of outwards as shown on the drawings.

If No. III is to be carried out, I would strongly recommend a slight modification of it, as shown by the blue lines which I have drawn on the plan No. III that accompanies the report of the Committee.

Government of India Central Printing Office.—No. 1019 P. W. D.—25-2-88.—50.

106 in by 28/2/88

20
£ s. d.

PUBLIC WORKS DEPARTMENT.

PROCEEDINGS OF THE MADRAS GOVERNMENT.

~~Home~~ Dated the

READ the following

Letter from the Government of India No 261 A.
dated 23rd May 1888.

In continuation of Public Works Depart-
-ment No 106 A dated the 28th February 1888,
I am directed to forward for the information
of His Excellency the Governor-in-Council, the
accompanying copy of a further Note dated
the 5th May 1888, by Mr Molesworth, the
consulting Engineer to the Government of India
for State Railways, on the subject of the
best position for the entrance to the Madras
Harbour.

=

Order thereon No 1715W dated 9th June 1888

Communicate to the Chair-
-man Harbour Trust Board for early
remarks

remarks in continuation of G. C. 764 W dated 6th March 1888

(True Extract)

(Sgd) J. Hart Collr. R.E.
Secretary to Govt. P.W.D.

To
The Chairman N. T. Bd
With 10 copies of not & plan

Note by Mr. G. L. Molesworth, Consulting Engineer to the Government of India for State Railways, dated 5th May 1888, on the subject of the best position for the entrance to the Madras Harbour.

When I wrote my last note on the Madras Harbour, I had not seen the minutes of evidence which induced the Committee to prefer Plan No. III on "Nautical grounds." I have now had an opportunity of studying that evidence, and I would suggest for consideration a slight modification of the plan I originally suggested (marked No. IV). This modification consists simply in prolonging slightly further the eastern arm which I had suggested; and also slightly altering the tangent point from the north-eastern elbow so as to change its position instead of having it in the position in which it was originally built.

I have shewn the prolongation of the eastern arm sufficiently long to cover the opening and protect it from seas coming in, even at an angle of 30° from the normal direction.

In my report on the Madras Harbour, dated March 1st, 1882, paragraph 96, I advanced the opinion that "the *waves of a dangerous character must always "come in broadside to the shore or nearly so* whatever the position of the storm;" and in paragraphs 75 and 76 of that report, I gave my reasons for the opinion I advanced. This opinion is confirmed by the experience of nautical men, as given in the evidence. The direction of the waves is stated to be quite independent of the direction of the wind, and that the heavy swells come in nearly broadside to the shore, even when the wind is blowing off the shore. Others state that the direction of the waves never exceeds an angle of 30° from the normal, but I doubt very much whether any waves, except those of oscillation, which are comparatively harmless, can possibly come in at any angle approaching this.

In fact, it is opposed to the laws, governing the motion of waves, that a *wave of translation* should deviate to any considerable extent from the parallel of the general direction of the contour lines of the bottom of the sea to seaward of the harbour.

An arm covering an angle of 30° will, however, be on the safe side, as protecting the entrance to the harbour, even from waves of oscillation.

I annex a sketch shewing the modifications I would propose in my original suggestion. The existing work being shewn in black lines; my suggestion of July 1883 in red lines; and the slight modifications I now propose in blue lines.

These modifications will, in my opinion, meet any objections that may be raised on "nautical grounds" to my original suggestions, whilst they will be free from some of the objections to which Project No. III is exposed.

G. C. Press, Simla.—No. 200 P. W. D.—18-5-88.—50.

Harbour Trust Board Office,

MADRAS, 21st June 1888

No. 1086

From R. W. Barlow Esquire C. S.

Chairman, Harbour Trust Board,

MADRAS,

To

The Honorable Mr. H. E. Stokes C. S.

Chief Secretary to Government,

Marine Department.

Sir

I have the honor to acknowledge G. O. No. 1718 W dated the 9th instant, forwarding for the remarks of the Board, a note with plan attached by Sir G. Molesworth regarding the best position for a North East entrance to this Harbour. These were, after circulation, very carefully considered at the Meeting of the Trustees on the 19th instant, and I submit Copy of the resolution then passed, together with Copy of a letter from the Board's Engineer, No. 368 dated 18th idem, replying to a reference made to him

on the subject.

2. Sir G. Molesworth's plan, if carried out, would give the Harbour a slightly larger area, but this would be of no practical use for the anchorage of vessels; it would also afford additional protection against waves of translation, coming in at a maximum angle of 30° from north of the normal direction, but the Trustees note that Sir Gilford gives it also as his opinion that "waves of a dangerous Character "must always come in broadside "to the shore, or nearly so," and in this the Trust fully concur, while they also agree with him that "waves of oscillation" are "Comparatively "harmless" - even should they come in at an angle approaching 30°.

3. The Board consider that they would not be justified in incurring the additional heavy expenditure and delay, which the adoption of Sir G. Molesworth design would involve. The junction of the new curves, at the North and South arms

arms, with the old works left undamaged by the Cyclone of 12th November 1881, proved a most difficult and costly undertaking, and the Trust are not disposed to accept any modification that would involve a repetition of this at the North arm. The revised plan would further necessitate the removal of a considerable portion of the new work at the Northern arm, at a heavy outlay, protected as it is by a 40 feet wave-breaker screen. The proposed alteration would, besides, carry the South arm into deeper water - as pointed out by our Engineer - involving still further expenditure. Under a review of the above Conditions the Board are decidedly opposed to the modification suggested by Sir G. Molesworth, and adhere

to

to plans III or IV, as already submitted to Government.

I have the honor to be
Sir
Your most obedient Servant

W Morrison

Chairman
Barbour Trust Board

Sec

G.O. 1715 W. dy 9.6.88.
- 151 Marine dy 25.4.88
- 153 W. dy 16.1.88
- 404 W. dy 4.2.88
~~3484 W. - 20.12.87~~
2846. - 24.1.88.
2978 W. - 7.11.87.
1895 W. - 14.7.87
1765 W. - 1.7.87
1590 W. - 14.6.87
3484 W. - 20.12.87

P.W.C. 106873

MARINE DEPARTMENT.

FROM

THE CHAIRMAN,

HARBOUR TRUST BOARD,

MADRAS,

TO

THE CHIEF SECRETARY TO GOVERNMENT,

Marine Department.

Acknowledged.

DATED 21st June 1888.

RECEIVED 23 June 1888.

ENCLOSURE 12

No. 1086

SUBJECT.

Replying to a reference to the Board made regarding modified plan for an entrance to the Madras Harbour by Sir Guilford Molesworth.

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Transferred to the Public Works Department

W Elkins
Chairman

Ackd 21 June 88

M.S. 135 VI 88. From Chairman Harbour Trust Board Re Co. Wks Cir. E. 1/88

Madras 18th June 1888

No 368

Rec'd 19 24

From

The Superintendent
Madras Harbour Works

To

The Chairman
Harbour Trust Board
Madras

Sir

I have the honour to return herewith the papers which accompanied your letter No 954 of June 13 with Sir Guilford Molesworth's modified plan for an Entrance to the Madras Harbour.

It appears to me that nearly the whole of the outer portion of the North pier will have to be taken up to carry out the design proposed, and the greater depth of water into which the South arm is brought will undoubtedly add to the cost of the work and increase the time of construction.

I have the honour to be
Sir
Your most obedient Servant
(Signed) F. T. Thorowgood
Superintendent

HARBOUR TRUST BOARD
21 JUN. 88
MADRAS.

/True Copy/
C Pinhey
Secretary
Harbour Trust Board

Copy

EXTRACT of Proceedings of the TRUSTEES of the HARBOUR of MADRAS, at a Meeting held at the Offices of the Board on Tuesday the 19 day of June 1888.

9. Read letter from the Engineer Harbour Trust Board No 368 dated 18 June 1888 Submitting report upon the modified plan for an entrance to the Madras Harbour by Sir Guilford Molesworth, Communicated with G. O. No 1715 W. dated 9 June 1888.

Resolved that the additional protection afforded would not justify the increased expenditure and delay, which would be incurred by the necessity for taking up a large portion of the new work, recently constructed at the head of the North arm.

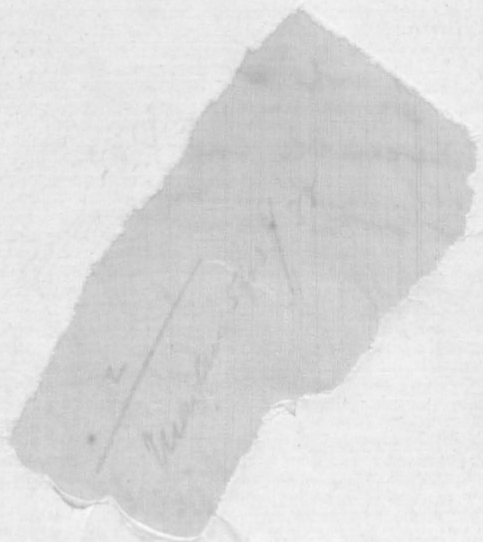
/True Extract/

C Pinckney

Secretary
Harbour Trust Board

HARBOUR TRUST BOARD
20 JUN. 88
MADRAS.





P.W. Dept

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Note.

To a member of the Committee appointed in 1883 which first suggested a North East entrance to the Harbour, a perusal of the report of the Committee appointed by the Secretary of State to consider the subject with the interesting notes of evidence, must be satisfactory. It seems now at last to be allowed generally that a North East entrance is necessary, and it is the opinion of eminent nautical men that steamers can enter and leave

the harbour by each an
entrance without much difficulty
2. His opinion was that the
one needed by the Government
3. There seems to be no
reason why the Government
should not accept without
hesitation the position of
entrance as approved by the
Home Committee, and
generally by the Harbour
Trust Board. The only apparent
objection to it is that it
necessitates the removal of
a very considerable extent
of old work which would
have been avoided by the
adoption of either Plan No. 1
(originally proposed) or

It has however the advantage
of opening in deeper water,
rather further from the shore
and this may be worth the
extra cost.
4. There is however another
plan very recently submitted
by Sir G. Molesworth,
which was not before the
Home Committee, and which
coming from such an authority
deserves consideration. This
plan is a considerable modification
of one formerly submitted
by Sir G. Molesworth, as it
provides by an altered
form of the arms, for completely
sheltering the entrance from
waves approaching the coast
from any possible direction

mouth of the work, which the former plan did not. It will moreover prevent the accumulation within the harbour and will bring the entrance further from shore than the plan approved by the Home Committee. It will appear therefore the proposal is a good one, but we have no estimate of its cost, and it is evident from the length of the arms and the depth of water in which they are to be constructed, that if it must exceed that of the proposal by the Home Committee, which it would [illegible]

Plan

remained, in one case as in the other, the Harbour Trust Board are opposed to the scheme (see their letter No 1086 of June 21, 1888).

It is right that Sir G. McLeay's note and proposal should be laid before the Secretary of State, but it seems to be questionable whether the advantages which it promises are sufficient to warrant additional outlay, and consequent delay in completion of the Harbour.

5. In his remarks on the report of the Home Committee Mr Parkes enters very fully into the subject of the advance of sand on the works which the entrance

before the Committee had
them to purpose was a very
serious matter, and which
they adduced as one reason
for their preference for a
North East entrance. The
Harbour Board briefly
discussed the subject,
considering that it was
better for present purposes
retained and that the
Committee have in possession
information that Mr
Larkin stated to be required
after the sittings of the
Committee, they would
probably never have attended
to the subject. The Committee
then adjourned until
10 o'clock

1887 and from the proceedings
in 1886 came to the conclusion
that the yard was advancing
south of the works faster
than was anticipated. Mr
Larkin maintained that the
apparent advance in 1886
was due to the heavy cyclone
in May 1886 and would
not be found to be a real
advance. the information
which he required after
the Committee ceased their
sittings was from a survey
made in September 1887,
and which showed that
the actual advance during
the year near the works was
considerably less than that
anticipated by the Committee

"intercepted when it becomes
"necessary, and what the
"cost of intercepting it will be.
"It may be added that
"that cost, which will not be
"required for 50 years, will
"not therefore be a serious
"burden on the trade."
It is submitted that Mr
Parkes' views on the question
are sound and that the
advance of sand is not a
matter for present consideration.

6. Mr Parkes' views as to
the question of a North East
entrance are not definitely
stated in his remarks on the
Committee's report. He refers
to the conflict of opinions between
the two Committees appointed

Mr certainly strengthens
Mr Parkes position, and the
result of examination made at
different times, of the sanding
leads to the conclusion that
the advance of sand will
not be considered a prob-
serious matter as the Committee
think. The Committee
consider the pond will
have ceased to the end of
the period even for 20 years,
Mr Parkes says 50 or 60
years, but he calls attention
to another point, he says
"I contend that it is now
"well established how the
"sand moves, and in what
"quantities it comes, and
"therefore how it may be

by the Secretary of State,
and officially conclude the
question to be still unsettled.
He dislikes altering the present
strong feeling in favour of the
North East entrance till he
personally at Madras, and
suggests that Capt Taylor's
successor may hold different
views, but the Harbour
Improvement Board is strongly
ready and that the general
view of the question by all
the present opinions. He
thinks it may be replied that
from June 1883 when the
Committee appointed in Madras
proposed the North East
entrance, all authorities
in Madras have pronounced

advocated the North East
entrance. The Harbour Improvement
Board from the date of
their constitution were strongly
in favor of it, and as at
present constituted, with the
exception of the late Capt
Taylor as member, have
expressed themselves more
strongly than ever in favor
of it, and the financial
position has been carefully
estimated by the Board
and pronounced by Govt
in GO. No 151 Marine of
15th April 1884. The Govt
have always been in favor of
the North East entrance, the
allowing that the question
was one on which practical

by the Secretary of State,
and officially conclude the
question to be still unsettled.
He dislike better the present
strong feeling in favour of the
North East entrance will be
permanent at Madras, and
suggests that Capt Taylor's
successor may hold different
views, that the Harbour
Joint Board is a changing
body and that the framed
view of the question by the
the present opinion. To
this it may be replied that
from June 1883 when the
Committee appointed to Madras
proposed the North East
entrance, all authorities
in Madras have persistently

advocated the North East
entrance. The Harbour Joint
Board from the date of
their Constitution were strongly
in favor of it, and as at
present constituted, with the
exception of the late Capt
Taylor as member, have
expressed themselves more
strongly than ever in favor
of it, and the financial
position has been carefully
estimated by the Board
and sanctioned by Govt
in GO. No 151 Marine dy
25th April 1888. The Govt
have always been in favor of
the North East entrance, the
allowing that the question
was not on which matters

opinion deserved the highest consideration, and, as that Committee of eminent naval and engineering authorities, selected by the Secretary of State, have reported in favor of it, it is considered that the question should be finally disposed of and the North East entrance adopted. (considering therefore the question settled and the form of entrance suggested by the Above Committee adopted, it remains to be decided how the work is to be carried out, and on this point the Board be little to say. Mr Parker is evidently

in favor of proceeding on the sanctioned plan till each pier is built to within about 300 feet of its termination in fact, almost completing the Harbour on the present sanctioned designs, and then commencing part of the work to form a North East entrance. He suggests that the question of a change of entrance might then be reconsidered, but following that has been paid above this suggestion should be rejected. He says "To carry "the work to that extent "would take about eighteen "months, during every month "of which time the shelter

would be injuring. To
proceed on the plan recommended
by the Committee, the first
two or three years would be
spent in opening the harbour
still more to the sea, and
that in the most dangerous
possible form, while a further
three years would be required
before anything like efficient
shelter would be obtained."
This may be true, but it has
to be remarked that the
work to be removed to form a
North East entrance at present
is much scattered and
comparatively easy of removal,
while if the Harbour is
nearly completed on the
present design, the work

to be removed will be the
strongest part, most carefully
fitted together, and the
difficulty of removing it
may then be considered
too serious to be overcome.
In either case special
machinery will probably
have to be procured for
the removal of the old work
and one ought to have
careful estimates of what
the cost would be in both
cases. It may possibly
prove, as the best way of
completing the Harbour expe-
ditiously, that the Mutton
arm should be nearly
completed on the line of
the present design or that

one exposed middle mid
in enclosing the protecting
arm of the Committee's proposed
plan, while another protecting
on the Southern arm, but it
can hardly be the most
economical plan, and it
should be considered, if
this method of working is to be
adopted, whether the section
of the work, which will only
have to stand for one year or
two, should not be modified
with a view to the easy
removal of the blocks as
soon as the protecting arm
is completed. The most
economical method of working
would, it is believed, be
to close the North East

entrance as expeditiously as
possible and then close the
existing entrance and proceed
on the protecting arm, for
which a very large amount
of material would be in
readiness. The Harbour
would be more exposed than
it is at present for the time,
but probably during those
only
it would be for a few days
in the N. E monsoon that
the sea inside would be
too rough for work; during
the S.W. monsoon it would
be quite sheltered.

8. If the question of a
North East entrance is now
definitely settled, this
question of how the removed

plans is to be carried out
will be of the first importance
The Board infer, it is
suggested be asked to
prepare detailed estimates
of the cost of removing the
old work; and to state their
views on the subject of
opening the North East
entrance at once, in order
that there should be no
delay in proceeding with
the work on receipt of
approval of the Secretary
of State to a change in
design.—

Bangalore
June 27, 1885

Secretary Colombo
Chief Engineer
B.B.

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151

Public Works Department.

PROCEEDINGS OF THE MADRAS GOVERNMENT.

Dated the 11th July 1855

Read the following

G.O. Marine N: 151 of 25th April 1855.
N: 764 W. d/ 6th March 1855.
N: 1715 W. d/ 9th June 1855.
Letter from the ~~Secretary to Govt~~ Marine Depart N: 1086 d/ 21st June 1855.
~~to~~ in the marine depart d/ 23d —
Note by the Chief Engineer d/ 27th June 1855.

In accordance with the earnest request of the Government, in their letter N: 1437 W & dated 9th June 1854 to the Secretary to the Govt of India, that the question of a North East entrance to the Harbour should be referred to some competent scientific authority, the Right Honble the Secretary of State

appointed a Committee
composed of Admirals Seymour
and Nares and Sir J. Coode,
to report on the project.

2. The Government
has paid full weight
the Committee's report and the
voluminous notes of evidence
taken by them, and is
gratified to learn that the
Committee shares the views
held by this Government
as well as by all competent
authorities in the Presidency
and in favour of a entrance
at the North East corner of
the Harbour, with a converging
arm.

3. The plan proposed
by the Committee and which

are generally approved
by the Harbour Trust
Board and by the Chief
Engineer is accepted by
the Government.

4. The Harbour Trust
Board will be requested
to submit their views as to
the best method of carrying
out the plan proposed by
the Committee, with an
estimate of the cost, and
of any further machinery
that may be required, and
the Secretary of State will
be asked to communicate
by wire his sanction to the
prosecution of the work
on the Committee's

design.

Ordered that the Secretary
of State be addressed.

(E. No 5 to 6 d/)

To

The Right Honorable
The Secretary of State for India
London.

My Lord,

We have the honor to
acknowledge receipt of your
Lordship's despatches No.
6 Rv dated 6th May 1857
No 10 Rv dated 26th November
1857 & No 11 Rv dated 15th
December 1857, respectively
with the report of the Committee

Ind. No 11 of 1858

Copy of this above, with
copy of the despatch to the
Secretary of State, forwarded
for the information of the
Govt of India.

(Added under instructions
from the Govt)

No 3 (4) 58

To Mr Commissioner &c. &c. &c.
- Marine dated
Dec 1857

appointed by your Lordship
to consider the best position
for the entrance to the
Madras Harbour and under
consideration; and remarks
by Mr Parker thereon.

2 We have communicated
these papers to the Harbour
Trust Board and have
now the honor to forward
for your Lordship's perusal
copy of our Proceedings

No 6 of 1858

embodying a report by the
Board and a note by the
Chief Engineer, P.W. Dept.

3. We have carefully
considered all that has
been written on the subject

and are prepared to accept
the plan proposed by the
Committee which we consider
will best meet all requirements.
We would however call
your Lordship's attention to
a plan recently proposed
by Sir G. Molesworth
which would also we think
meet all requirements, and
possesses some advantages
which the Committees'
plan does not, but would
we consider prove more
costly.

4. We shall await
intimation from your
Lordship that the plan
proposed by the

[illegible]

re letter from Chairman
Hudson Trust Board &
[illegible]

has been finally adopted,
which must leave the time to
[illegible] request may be made by
telegraph [illegible] Meanwhile we have
called on the Hudson
Trust Board for an
expression of their views
as to the best means of
carrying out the proposed
plan with detailed estimate
of the cost. We are fully
aware of the necessity for
adopting an expeditious
method of carrying out the
works to completion, but we
are not convinced that
Mr Parkes proposal to
nearly complete the work
on the existing sanctioned

plans before clearing the
Middle Est entrance will
prove convenient or —
satisfactory.

5. We have the honor to
submit for Lordships favorable
consideration of the Board's
request that the rate of
interest upon capital advances
may be reduced from
4½ to 4 per cent per annum
which appears to us reasonable,
and we have to call
Your Lordships attention
with reference
to the concluding paragraph
of the Chairman's letter
No 69 dated 6th April 1883

Dec 4/6

Jan 27/1886

I am of opinion that an
Exhibition Commission & the
following Offices shd be made
to para 2

"Whether an entrance at
the corner would possess the
Exhibitional advantage of
being fully protected against
Naval attack by the shore
batteries which is proposed
to construct to the North of the
Harbour: that an entrance
in the centre of the Eastern
Face can receive the little
protection from shore batteries
and that even could, within
a certain distance, afford
cover to boats attempting
to force an entrance for the
purpose of destroying the
Shipping in the Harbour."

C.G.L.
10.7.86

31
185

154

Govt. of [1888] Madras.

PUBLIC WORKS.

3/8/88

Madras Harbour

Drawing on Rep on report and plan of the Harbour Committee as regards the best position

Madras Harbour

Forwarding for information copy of proceedings passing orders on report of Committee as regards best position for an entrance to the Harbour, together with copy of despatch to the Secy of State

Forwarding copy of proceedings on the report of the Harbour Committee regarding the best position for an entrance to the Madras Harbour & requesting early intimation of the final decision after Committee of Com.

P.W.D.

Telegram
— 159.

To, The Secy of State.

—

Your despatch No 1335 first August last. Harbour authorities request defer orders pending receipt of detailed plans and estimates. Apparently they are coming round to view 34 of Mr Parkes's letter 5th November last.

(Sgd.)
(by order)
H. Mead. Col. RE
4/6

H.M. Tel of 4th
Madras Harbour 1587
There is no copy of the
telegram sent to the
Secy of State
No 1335 of 1st Aug
There added a copy
Mead 4/88

Secy
Copy of telegram
submitted. J.P.
4-6-88

159

GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

Buildings and Roads.
Civil Works.

READ—the following paper:—

Telegram from the Chairman, Harbour Trust Board, Madras, to the Chief Secretary to Government, dated 5th October 1888.

Referring to G.O., No. 2335 W., 1st August 1888, the Board have considered proposals submitted by their Engineer for north-east entrance. Detailed plans and estimates will follow in ten days with explanatory letter. Board consider that the Secretary of State should be asked by wire immediately to postpone sanction to any design for entrance pending receipt of Board's proposals, which will allow work to proceed for a time at both arms on the revised sanctioned design published with G.O., No. 3127 W., 19th December 1884.

Transferred to the Public Works Department.

(Signed) J. F. PRICE,
Acting Chief Secretary.

ORDER—dated 13th October 1888, No. 3259 W., Public Works.

Ordered that the Secretary of State be addressed accordingly by wire.

(True Extract.)

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

To the Chairman, Harbour Trust Board.
" Marine Department.

Exd. J. Henricus.
Spare Copies

BUILDINGS AND ROADS.
CIVIL WORKS.

Govt. of [1888] Madras

PUBLIC WORKS.

Dated October, 1888.

Read

Ord. 13th Oct. 1888, No. 3259 P

OCTOBER.

North-east Entrance to the Madras Harbour

Telegram to the Secretary of State requesting orders on the subject of the — may be delivered pending receipt of plans and estimates.

164.

No. 909.

From

A. LEE POGSON Esq.,
Engineer, Harbour Trust Board, Madras,

To

THE CHAIRMAN, HARBOUR TRUST BOARD, MADRAS.

SIR,

In reply to your letter No. 1952, dated 9th August, forwarding the Board's Proceedings of 7th August 1888, and calling for further information regarding the cost of carrying out a north-east entrance under design No. III.

1 Mounted detail plan.
1 Tracing of do.
2 Lithographed plans, with estimates 1 to 5.

2. I have the honor to state that I consider Mr. Thorowgood's letter No. 1404, dated 16th February 1888, with his estimate of Rs. 75,98,414, to be as explanatory as I can make it, considering the uncertainty of ever being able to remove the ruins by floating dredgers; and the detail plan I now submit will, I hope, convince all concerned that the only reliable way to raise or remove the old wall is from a fixed base, viz., a masonry pier. Of course had there been 10 or 15 feet of water over the ruins, a dredger would have no difficulty in working.

3. With my proposition to remove the old wall, I propose to use a crane (working from a temporary structure), and therewith dredge down to a depth of 20 feet, *then* remove the rubble with a floating dredger.

4. To commence dredging, and to open a north-east entrance at once, as in design No. III, would be an irrevocable decision and would condemn, without a fair trial, a design which has been approved of by eminent engineers and authorities. I certainly think a design (for an entrance) preferable where the eastern entrance can first be *proved* a failure, or otherwise; before condemning it and thereby delaying completion for 4½ years, besides burdening the port with an additional outlay of upwards of 26 lakhs, that may or may not give all the requirements, and shelter to future jetties, wharves, and heavy lighters, which it is wished to obtain.

5. Under these circumstances, I have endeavoured to produce a design for a north-east entrance which will overcome all these difficulties and put Mr. Parkes' design to the test; and should the water eventually be found smooth enough for the shipping, the harbour could be completed on the sanctioned design and probably within the cost of the estimate. Then I should urge the Trustees to look to improvements inside the harbour, to secure the cranes, lighters, sailing ships, and native craft in cyclones. This I propose to carry out by building the inner walls shown on the lithographed plan and estimate No. 5 at a cost of Rs. 12,80,213.

6. If Mr. Parkes' design does not give smooth enough water for all practical purposes, then my design No. IV-A could be proceeded with, and completed in five years from now, at an extra cost of Rs. 21,58,999.

7. The mode of procedure under design IV-A, estimate No. 2, for *Rs.* 71,31,595, will be as follows.

8. *Design No. IV-A, North Pier.*—The north pier will be proceeded with strictly in accordance with the sanctioned design as far as point A.

9. *From* A to B a pier of the sanctioned bonded superstructure will be built, but not protected with wavebreakers, until the eastern entrance has been tested and accepted or *condemned*. If the former case, the pier from A to B can be made permanent by adding the "wavebreaker," &c., in a very short time. If the latter decision is come to, then I propose to dredge up the old wall with the combined "wavebreaker and dredging crane," down to the rubble base; then remove the temporary wall (in blue on plan), the blocks to be transferred and re-set at the south pier; advancing it as the north pier recedes; and thus maintaining an entrance varying from 560 feet to 550 feet, but gradually *deepening* into a north-east entrance. The rubble base would be dredged up in sections of 50 feet with a self-propelling Priestman's dredger.

10. *South Pier.*—The south pier will proceed as far as point C as fast as possible, and will also be strictly in accordance with the sanctioned design, and be thoroughly protected with wavebreaker blocks and the old wall.

11. At the south pier we have the wavebreaker crane already transferred from the north pier.

12. *Time of completion.*—In two years and ten months from the time of commencement, the points B and C would have been reached, and the harbour would then have an eastern entrance of 527 feet (but without the pier heads, hereafter explained), at a cost of Rs. 14,95,791 from 31st August 1880—see estimate No. 4.

13. It will then be for the Trustees to decide whether the sanctioned design is to be completed, or whether my design for a north-east entrance is to be carried out; in other words, whether they prefer to spend Rs. 12,80,213 to "improve the facilities for landing and shipping cargo" as fast as they can be discharged from the ship's side, and enabling them to have 100-ton iron lighters ready loaded and alongside within an hour after the return of a steamer which has had to proceed to sea during a cyclone; or whether they will spend an additional Rs. 21,58,939 over the north-east entrance No. IV-A and do without the landing and beach improvements, till the port can afford the extra outlay.

14. Should the position of the north-east entrance, then ultimately decided upon, be No. IV-A, no money will have been wasted on the test, and *condemnation* of Mr. Parkes' design; and the north-east entrance can be proceeded with at once as in estimate No. 2, and will have cost from 1875, Rs. 71,31,595 when completed.

15. *Extension.*—If on reaching the end of the southern arm the overlap is not considered sufficient, the extension shown in red (dotted lines) can be added, which will give the same overlapping angle as in design No. III at a total cost given in estimate No. 2, which will be Rs. 74,56,566; but the overlapping angle in design IV-A already exceeds that considered sufficient by Sir G. Molesworth, and I think the Trustees could not do better, than to accept an opinion coming from so high an authority as decisive.

16. I may add that the depth of water at the pier head No. IV-A will only be one foot greater than pier head No. III; but this extra depth will not weaken the arm, as I have allowed (in the quantities) for the base being 11 feet wider than in No. III and the pier head, which I propose, will be 50 feet across as against Mr. Parkes' pier head 38 feet in width.

17. *Pier Heads.*—The pier heads shown in estimate No. 1 include the superstructure, wavebreaker and base, &c., complete, from the commencement of widening out from the 24 feet wall. These pier heads, under the present design, necessitate a decision being arrived at when the piers have advanced to within 550 feet from the end of each pier head, so that with 600 feet short length of piers, added to the sanctioned entrance of 450 feet, there would remain (as a minimum) an opening of 1,050 feet, and if a north-east entrance is then decided upon, this would mean condemning Mr. Parkes' design before it has had a fair trial.

18. But, with a view to proving whether the eastern entrance will be the anticipated failure or not, I have designed a pier head (a model of which I shall be able to submit to the Trustees in a few days, with a detailed drawing), under which a pier head can be formed, at any distance along the arm, at a cost of Rs. 96,624 (see estimate No. 2, South Pier). By this means, the main piers can be advanced to

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within 38' 6" short of the proposed ends of the pier heads, so that, to test an entrance of 450 feet, I can give (temporarily) an entrance 23 feet narrower than the entrance *was* in November 1881, viz., Mr. Parkes' entrance = 450' + 38' 6" N.P. + 38' 6" S.P. = 527 *feet*; entrance of November 1881 = 550' — 527' = 23 feet less than the old design. I can then, under my design, add the pier heads, and complete an entrance of 450 feet; or, at the Trustees' option, remove the north pier between A and B, still unprotected by the wavebreaker, and extend the south pier, if a north-east entrance is to be carried out; while with Mr. Parkes' old design for the pier heads the work must be permanent.

19. Another point strongly in favor of my design for a pier head, is that the cost will be considerably reduced, as the Titan cranes will work straight ahead; while to build the pier heads as constructed in 1881, the present cranes will have to be turned after every course set, and no one knows better than I what will be the difficulty, responsibility, and extra labor.

ESTIMATES.

20. *Estimate No.* 1.—Estimate No. 1, for sanctioned design, gives the quantities and cost under each head separately, and the time of completion is shown on the plan.

21. It should be noted that a new wavebreaker crane will be required for the north pier at once.

22. *Estimate No.* 2.—Estimate No. 2 for design No. IV-A also gives quantities and cost under each head, including a list of the new machinery, cranes, &c., required.

23. The dredgers will not be required until the position of the entrance has been decided upon, *after* the points B and C have been reached, by which time shelter for them will be available, and smooth water obtained, to a greater extent than intended in the original design.

24. *Estimate No.* 3.—Mr. Thorowgood's estimate No. 3, herewith submitted, for design No. III is all that I have on record. I wish here to call your attention to the fact that the time of completion is stated at seven years, from the date of arrival of dredging plant, "probably one year," so that the total time will be eight years to complete the design; and then the question arises, what is to be done with the floating dredgers meanwhile, in a harbour which is being "opened" for the next four years, and must consequently be completely exposed to swell and sea. Under such conditions, I anticipate complete destruction to all the dredgers and proposed landing arrangements, now being carried out, in the first cyclone that strikes Madras, as the north-east monsoon swell must enter the harbour as freely as it rolled in, on the beach previous to 1876.

25. *Estimate No.* 4.—Estimate No. 4 is for completing the north pier permanently to point A; without the wavebreaker to B; and the south pier to C, permanently.

26. The time of completion is the quickest of any, and is meeting Mr. Parkes' design by first testing the "smoothness" of the water, in the harbour, under an eastern entrance, which can be decided upon in two years and ten months, at a cost from now of Rs. 14,95,791.

27. The only risk, if any, is in the wall from A to B not being protected with a wavebreaker; but the old pier in front of it is so little damaged, that it will give a substantial protection in itself to the new pier, and I feel sure Mr. Parkes will consider the risk not worth mentioning, when weighed against the opportunity gained to prove to the Trustees what the harbour will be when completed.

28. If any damage should be done, and the wall partly overthrown, the loss would probably not exceed one lakh.

29. It must be remembered that the present section of pier is bonded in every way, whereas the old section had no bond and a open centre joint from top to bottom.

30. The Trustees will see that under this scheme I can produce a harbour which will shelter a dredger on arrival, and that every rupee outlaid on the harbour construction, from now, will give a *steady improvement* and *shut out* the sea; while with design No. III, 13¼ lakhs will have to be spent, during the next three and half to

four years, is *removing a most valuable protection* which strengthens the new wall to an unknown extent, which protection I utilise under both my suggestions.

31. *Estimate No. 5.*—Estimate No. 5 is for improvements inside the harbour as soon as the eastern entrance has been reached, or design IV-A completed.

32. Reckoning on smoother water, the rate of progress will be much quicker, consequently the estimate lower.

33. Under this estimate, I proposed to run two walls or piers of bonded work, 24 feet wide, as shown on the lithographed plan, with an entrance of 100 feet; each arm just to overlap the other.

34. The inner harbour thus formed could then be dredged to 4½ fathoms; but as estimated for at Rs. 12,80,213, it would be 4½ fathoms deep for a width of 300 feet immediately westward of these inner walls, and the water would be perfectly smooth, *even in a storm*.

35. All native craft, and sailing vessels, would herein be securely sheltered and be perfectly safe; so that the inner harbour would literally be a *Harbour of Refuge* to sailing vessels, native craft and the proposed 100-ton lighters. The outer harbour would then only be for steamers, which must always proceed to sea during a cyclone. In this inner harbour 100-ton lighters could be loaded in any weather (except heavy rain) and be ready, waiting on the return of any steamers which may have been ordered to proceed to sea to escape a cyclone.

Rates.

36. *Cost of Entrance.*—In concluding, I must state that my rates for labor are much higher than those quoted by Mr. Thorowgood; but I venture to ask the Trustees to accept these rates, as I have based them upon the actual cost of the new work during the last two years.

37. It is true the past two years have been the least favorable for marine work of this nature, for many years past, but the error, or excess, in rates, and time of completion, will be on the safe side.

38. Mr. Parkes' rates for the old work are insufficient now, as the Titan cranes then worked all the year round (weather permitting of course) and simply built straight a head; but with the present protective work, and in accordance with the Government orders, the cranes have to be run on shore twice a year; while further, at the end of each season's work, nearly a month is taken up in protecting the piers and depositing the wavebreaker blocks—so that where twelve months was a working year formerly, I can only work at advancing the pier for about eight months in the year. But these higher rates, and rate of progress, will not affect the estimates if compared with each other, as I have taken the same rates both as to the cost and progress in compiling all the estimates, with the exception of estimate No. 3, and I fear, if my rates were applied to Mr. Thorowgood's quantities, the cost of design No. III, and the time required for its completion, would be considerably enhanced.

Plans.

39. *Lithographed Plan Design IV-A.*—The lithographed plan shows the harbour under design IV-A with a north-east entrance, and the 4½ fathom inner harbour completed.

40. *Detailed Plan and Sections, Design IV-A.*—The plan and sections (scale of 40 feet = 1 inch*) give design IV-A in detail, and it will be seen at a glance, more clearly than can be described in a letter, how I intend the work to be carried out.

41. The *scale* on this plan gives all the required information as to the cost, time of completion, &c.

42. I have produced this large scale-drawing, with cross sections, with a view to showing the Trustees what is really below the level of the sea, as I believe it is hardly credited what a mountain of rubble and blocks would have to be removed to carry out No. III entrance, which must, moreover, render the harbour useless for next three

* A plan, on a reduced scale, in sufficient harbour, for ready reference.

or four years, so I cannot too strongly urge the Trustees to fully consider the serious results of such action, before sanctioning so irrevocable a step, as to allow the harbour to be thus thrown open to the sea, which would, I fear, be most disastrous to the trade of the Port of Madras, and immensely prolong the great disadvantages, resulting from an incomplete harbour, which must force a most severe tax upon the mercantile community; while, under my plan and estimate No. 4, these disadvantages will be removed, as speedily as possible, and the Trustees can, instead of relying upon *theories*, decide after a practical experience what design of entrance is ultimately to be adopted.

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

A. LEE POGSON,
Engineer, Harbour Trust Board.

Madras,
1*st October* 1888.

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MADRAS HARBOUR WORKS.

ESTIMATES

ACCOMPANYING THE ENGINEER'S LETTER No. 959, DATED 1ST OCTOBER 1888.

SUMMARY OF ESTIMATES.

Pages from	Description.	Cost from 31st August 1888.	Cost from 31st August 1888, with sanctioned outlay.	Total cost of Harbour.	Time of completion from commencing work at North Pier.
		Rs.	Rs.	Rs.	yrs. m.
7 to 9	Estimate No. 1, for completing sanctioned Design (Eastern entrance).	10,17,893	16,73,705	16,73,705	3 6
9 to 11	Do. — 2, for completing Design No. IV-A (South-east entrance).	61,12,760	64,73,482	71,35,588	5 0
13	Do. — 3, Design No. III (North-east entrance).	* 63,31,891	64,16,373	73,38,454	5 0
14	Do. — 4, to give smooth water as in November 1882.	14,36,781	Temporary	81,47,888	5 10
15	Estimate No. 5, for Improvements inside Harbour to be commenced when alternate entrance is formed.			13,66,513	Time not ascertained.

* Time of commencement, calculated from February 1st, 1889.

MADRAS HARBOUR WORKS OFFICE,
RAYAPURAM,
MADRAS, 1st *October* 1888.

(Signed) A. LEE POGSON,
Engineer, Harbour Trust Board.

1634

ESTIMATE No. 1.

To complete sanctioned Design from 31st August 1888.

Total Expenditure, Rs. 26,52,113.

Abstract of Estimate, after 31st August 1888.

Completed less Concrete Capping to 2,526'.

North Pier.

	Rs.	Rs.
Additional rubble— 6,979 tons, at Rs. 2	13,958	
Superstructure— Deducting stock = 718', at Rs. 345½ per lineal foot, including setting	2,48,104	
Add cost of setting 334' on stock, at Rs. 103·75 per lineal foot	34,653	
Wavebreaker— 1,052 lineal ft. (40' wide), at Rs. 297 per lineal ft. including setting complete	3,12,444	
Concrete in bags— From 2,600 ft. to 3,578 ft., at Rs. 12 per cub. yd. including setting	17,387	
Cramps— From 2,526' to 3,576' fixed, complete, at Rs. 6 each ...	1,044	
Removing old blocks on line of new work 180 rg. ft. (to be blasted), at Rs. 10 per foot	1,800	
Wavebreaker Crane— Duplicate, delivered and erected	59,635	
Add for Pier head sanctioned design complete, including rubble, superstructure, wavebreaker, setting apron blocks, and cramps	3,28,868	
Total of North Pier sanctioned Design ...	...	10,17,893

South Pier.

Completed less Concrete Capping to 3,180'.

Abstract of Expenditure after 31st August 1888, less Pier heads.

	Rs.	Rs.
Additional rubble— 3,591 tons, at Rs. 2	7,182	
Superstructure— Deducting stock 386 rg. ft., at Rs. 345½ per rg. ft. including setting	1,33,333	
Add cost of setting 142 ft. of Pier on stock at 103·75 rupees per rg. ft.	14,732	
Wavebreaker— 528 lineal ft. (40 ft. wide), at Rs. 297 per lineal ft. including setting complete to 3,708' commencement of Pier head.	1,56,816	
Concrete in bags— From 2,900 ft. to 3,708 ft., at Rs. 12 per cub. yd. including setting	14,365	
Cramps— From 3,180' to 3,708' fixed complete, at Rs. 6 each... ...	516	
Add for Pier head sanctioned design complete, including rubble, superstructure, wavebreaker, setting apron blocks, and cramps	3,28,868	
Total for South Pier ...	6,55,812	
Add total for North Pier ...	10,17,893	
Total of North and South Piers ...	16,73,705	16,73,705

		Rs.	Rs.
Lighting Entrance—	Total of North and South Piers—contd. ...	16,73,705	
Add Rs. 10,500 (see Mr. Parkes' estimate)		10,000	
		16,83,705	
Repairs to machinery, extra Railway lines and sleepers ...		22,000	
		17,15,705	
Add 10 per cent. establishment		1,71,570	
Add 10 per cent. contingencies		1,71,570	
		20,58,845	
Deduct sale-proceeds of tools and plant		74,367	
	Total for sanctioned Design ...	19,84,478	
Add outlay to 31st August 1888 (approximate)		26,52,113	
Total cost of sanctioned Design completed ...		46,36,591	46,36,591
Concrete capping to North Pier		1,45,512	
Do. Do. to South do.		1,34,493	
Concrete capping to Piers		2,80,005	
Add for establishment 10 per cent.		28,000	
Add for contingencies 10 per cent.		28,000	
Total of capping to sanctioned Design ...		...	3,36,005
Total of sanctioned Design completed with capping ...		...	49,72,596

Book of Estimate No. 1.

(Signed) A. LEE FOGSON,
Engineer, Harbour Trust Board.

ESTIMATE No. 2.

To complete Design IV.A, as shown on Plan.

Abstract of Expenditure after 31st August 1888, from present termination of Piers, viz., North Pier = 2,526', South Pier = 3,180'.

North Pier.

		Rs.	Rs.
Superstructure—			
Permanent work to A = 3,292' shown on plan—			
Deducting stock = 432 rg ft., at Rs. 345½ per rg. ft., including setting		1,49,256	
Add cost of setting 334 ft. on stock, at Rs. 103·75 per lineal ft.		34,653	
Wavebreaker—			
From 2,526' to A—			
727 lineal ft. (40' wide), at Rs. 297 per lineal ft. including setting complete		2,15,919	
Concrete in bags—			
From 2,600' to A		14,436	
Cramps—			
From 2,526' to A = 127', at Rs. 6 each		762	
Total for North Pier complete, to A, shown in red on plan ...		...	4,15,026

North Pier, temporary work, shown in blue from A to B on Plan.

Temporary Work.

		Rs.	Rs.
Additional rubble—			
34,102 tons, at Rs. 2 per ton		68,204	
Superstructure—			
503 lineal ft., at Rs. 345½ per lineal ft. including setting ...		1,73,786	
Removing old blocks on line of new work—180 rg. ft. (to be blasted), at Rs. 10 per rg. ft.		* 1,800	
Total of Temporary Work (in blue) from A to B		2,43,790	
Total for Permanent Work to A, and Temporary to B ...		...	6,58,816
North Pier—			
Blasting, dredging, and removing old superstructure—			
1,486 blocks = 29,110 tons, at Rs. 4 per ton		1,16,440	
Removing temporary wall (in blue to be reset at the South Pier) taking up 503 ft., at Rs. 50 per rg. ft. between A and B		25,150	
Dredging rubble base—			
Total deposit of rubble to November 1881 (including old blocks blasted) ... ... = Tons	54,904		
Do. for restoration since October 1886. ,,	30,944		
Do. three-fourths of total deposit, new, for temporary wall ... ... ,,	25,576		
Total tons to be dredged, at Rs. 4 per ton.	1,11,424	4,45,696	
Total for dredging, blasting, and removing old ruins, and taking up temporary wall		...	5,87,286
Total for permanent work to A, and dredging and removing Pier between A and B		...	12,46,102

South Pier.

From 3,180′ to 1,405′ from shore.

Abstract of Expenditure after 31st August 1888 from present termination of Pier.

Additional rubble—	Rs.	Rs.
Deducting total of dredgings from North Pier — 2,91,546 tons, at Rs. 2 per ton	5,83,092	
Add cost of depositing in South Pier, dredgings from North Pier — 1,40,554 tons, at 4 annas	35,134	
Large rubble under Wavebreaker—		
From C to Pier head 22,436 tons, at Rs. 2 per ton deposited.	44,872	
Superstructure—		
From 3,180′ to Pier head (in red, deducting stock) = 1,341·36,′ at Rs. 241½ per lineal foot.	8,72,617	
Add cost of setting 2,186½ ft. pier on stock, at Rs. 103½ per lineal ft.	2,26,849	
Wavebreaker—		
2,186½ lineal ft. (40′ wide), at Rs. 297 per rng. ft., placed in position	6,49,291	
Concrete in bags—		
From 2,500′ to Pier head abutment, at Rs. 17½ per lineal ft.	43,397	
Cramps—		
New work, 355, at Rs. 6 each	2,130	
Add total of Pier head with abutment, wavebreaker, additional rubble, apron blocks, cramps and setting complete	95,644	
Total for South Pier complete including Pier head	20,51,316	
Total for North and South Piers, including dredging, &c.		39,97,418

Total for North Pier, completed to A	Rs.	Rs.
Do. do. Temporary work A to B	4,15,026	
Do. Dredging and removing wall between A and B	2,43,790	
Do. South Pier complete including Pier head ...	5,87,286	
Add cost of wavebreaker crane, dredger, and repairs to present machinery as per list A	20,51,316	
Add cost for lighting entrance	2,91,776	
Add 10 per cent. for establishment	20,000	
Add 10 per cent. for contingencies	3,51,919	
	3,51,919	
	42,21,032	
Deduct sale-proceeds for tools and plant	1,10,323	
Total for Design IV-A, from August 1888		41,12,709
Add outlay to 31st August 1888 (approximate)	26,52,113	
Total cost of Design IV-A complete		67,64,822

Concrete capping—	Rs.	Rs.
Concrete capping, North Pier	1,06,489	
Do. South Pier	1,99,156	
Total for North and South Piers	3,05,645	
Add establishment 10 per cent.	30,564	
Add contingencies 10 per cent.	30,564	
Total for capping to Design IV-A	...	3,66,773
Total for Design complete, with capping throughout	...	71,31,595

Extension to give an overlapping angle equal to Design No. III.

Extension to South Pier.

	Rs.	Rs.
Rubble stone in base—		
54,297 tons, at 2 Rs. per ton	1,08,594	
Large rubble under wavebreaker—		
3,088 tons, at Rs. 2 per ton	6,176	
Superstructure—		
195 rg. ft. set complete, at Rs. 345½ per rg. ft.	67,373	
Wavebreaker—		
195 feet, at Rs. 297, placed in position	57,915	
Concrete capping—		
195 rg. ft. at Rs. 53½ per rg. ft.	10,432	
Cramps—		
32, at Rs. 6 each fixed	192	
Concrete in bags—		
195 rg. ft., at Rs. 17½ per rg. ft.	3,461	
	2,54,143	
Add 10 per cent. for establishment	25,414	
Add 10 per cent. for contingencies	25,414	
Total for extension as shown (dotted red) on plan giving an overlapping angle equal to Design No. III including capping		3,04,971
Total for Design IV-A completed with extension and capping throughout		74,36,566

End of Estimate No. 2.

(Signed) A. LEE POGSON,
Engineer, Harbour Trust Board.

List A—Accompanying Estimate No. 7.

List of New Machinery, Plant and Repairs, &c., required under Design IV-A.

Number required.	Description.	English price at current exchange delivered here.		Remarks
		Each. Rs.	Total. Rs.	
1	One new Locomotive engine ...	23,010	23,010	As invoiced by *Mofussilite* in January 1877.
2	Two new Boilers for Stationery engine.	3,092	6,184	As invoiced by S.S. *Teesdale* in February 1876.
...	Renewing timber work and repairs to Elevators.	...	3,000	
...	Repairs to 20 old block Trucks.	100	2,000	
...	Do. for 8 do. with new timber.	120	960	
2	Two new Boilers for Goliath crane.	863	1,726	As invoiced by S.S. *Pelican* in May 1885.
...	Goliath cranes, repairs ...	...	2,909	
2	Two Steam cranes at mixing station, at Rs. 4,195 each, delivered in Madras.	4,195	8,390	
2	Two new Winches for overhead travellers.	81	162	As invoiced by S.S. *Chusan* in June 1885.
6	Six new Sand wagons	...	...	
...	Repairs to Sand wagons (old) ...	425	2,550	
...	Trollies, concrete skip-wheels and repairs, &c.	...	1,500	
18	Eighteen new concrete skip boxes.	...	2,088	
12	Twelve new Elevator boxes ...	60	1,380	
1	One new double-barrel Pump ...	30	300	
1	One new Crusher complete ...	...	600	As invoiced by S.S. *Chusan* in June 1885.
5	Five Eccentric shaftings for crushers.	5,480	5,480	As invoiced by S.S. *Athol* in November 1875.
45	Forty-five sets of Crusher jaws.	97	485	As invoiced by S.S. *Khedive* in March 1886.
1	One new Elevator complete ...	Pr. 131	5,955	As invoiced by S.S. *Guerbe* in June 1886.
...	Dining gear	401	931	As invoiced by S.S. *Sea Gull* in April 1876.
1	One wavebreaker and dredging Crane for North Pier to swing round.	...	1,500	
1	One Steam Tug (G.S. and P. and Co.) for rubble base deposit and survey purposes.	...	12,000	
1	One Barge fitted with hopper and open bottom, for discharging dredgings in deep water.	...	10,500	
2	Two Priestman's dredgers for above barge, capable of raising 1,500 tons per day (taken as 300 tons).	15,750	31,500	
	Extra Railway lines and Titan rails including sleepers, &c.	...	15,000	
	Total for New Machinery, Repairs, &c.	...	2,01,776	

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ESTIMATE No. 3.

By Mr. F. N. Thorowgood,
Madras Harbour Works.

Estimate of Cost of No. III Design, referred to in Superintendent's letter, No. 1404, dated February 16th, 1888.

	Rs.	Rs.
Taking up old work—		
Rubble—173,593 tons.		
Concrete blocks blasted, 64,531 tons.		
Total to be removed 238,124 tons, at Rs. 4	9,52,496	
Rubble to be deposited in base, 286,000 tons—		
Deduct old rubble dredged up, 238,124 tons, at 4 annas ...	59,531	
New rubble, say, 50,000 tons, at Rs. 2	1,00,000	
Superstructure—		
From January 31st, 1888—		
Work to be done up to Eastern entrance complete, 1,100 lineal feet, at Rs. 748	8,22,800	
Add capping from estimate	1,92,000	
From South Pier head to end, 2,200 feet, at Rs. 748 ...	16,45,600	
Wavebreaker extra to outer straight, 2,200 feet, at Rs. 90.	1,98,000	
Apron round pier head (estimate)	21,671	
Capping on new extended work, 2,200 lineal feet ...	1,17,330	
Concrete in bags (taken as 3 times original quantity) ...	27,000	
Dredging plant—2 Bruce's dredgers and 2 hoppers ...	1,50,000	
Repairs to engines, cranes, plant and railways	80,000	
Extra Railway lines	3,000	
Add 10 per cent. contingencies	4,36,942	
Add 10 per cent. establishment	4,36,942	
	52,43,312	
Deduct value of blocks on stock	2,20,000	
Total for 600 feet overlaps		50,13,312
or 800 feet overlap we have—		
Add to above 200 feet, at Rs. 748	1,49,600	
Wavebreaker 200 ,, at ,, 90	18,000	
Capping 200' × 24' × 6', at Rs. 10 per cubic yard ...	10,660	
Rubble, 30,000 tons, at Rs. 2	60,000	
		2,38,260
Expenditure to January 1888		23,46,842
Grand Total ...		75,98,414

(Signed) F. N. THOROWGOOD,
Superintendent, Madras Harbour Works.

End of Estimate No. 3.

(True Copy.)

(Signed) A. LEE POGSON,
Engineer, Harbour Trust Board.

ESTIMATE No. 4.

Estimate for completing North Pier to A (permanent), A to B (temporary), and South Pier to C, complete.

		Rs.	Rs.
North Pier—			
To A complete		4,15,056	
A to B temporary		2,43,760	
Total of North Pier to B			6,58,816
South Pier—			
To C			5,00,677
Add cost of W. B. and Dredging Crane and repairs to Machinery		5,00,677	
		87,000	
Total to B and C ...		12,46,493	
Add 10 per cent. for establishment		1,24,649	
Add 10 per cent. for contingencies		1,24,649	
Total cost of Harbour complete (less warehouse between A and B, and capping to B, North Pier, and capping to C, South Pier)			14,98,791

End of Estimate No. 4.

(Signed) A. LEE POGSON,
Engineer, Harbour Trust Board.

ESTIMATE No. 5.

Estimate for Improvements to inner portion of Harbour as shown in Lithograph Plan IV-A, to give perfectly smooth water, and security in storms to Beach improvements, 100 tons lighters, boats, &c.

	Rs.	Rs.
Dredging—		
Down to original sea bottom to deposit foundations to Piers, 44,444 cub. yds., at As. 8	22,222	
Rubble—		
96,075 tons, at Rs. 2	1,92,150	
Superstructure—		
3,063', at Rs. 268 per rg. ft. set complete	8,20,884	
Cramps—		
496 cramps, at Rs 6 each fixed	2,976	
Capping—		
1,361·3 cub. yds., at Rs. 10 per cub. yd.	13,613	
Total for Inner walls ...	10,51,845	
Add for repairs, rails and sleepers	15,000	
	10,66,845	
Add 10 per cent. for establishment	1,06,684	
Add 10 per cent. for contingencies	1,06,684	
Total for Inner walls, to give a 4½ fathom Boat Harbour capable of receiving Native craft and sailing vessels, &c. ...		12,80,213

Time of Completion.

	Y.	M.	D.
To complete Inner walls from date of commencement	1	7	0

End of Estimate No. 5.

(Signed) A. LEE POGSON,
Engineer, Harbour Trust Board.

To	From
Cotacammnd.	17th Madras
To Madras.	From Chairman Harbour Trust Board

Telegram Deferred.

Referring to G.O. number 2335 Works 1st August 1888. the Board have considered proposals submitted by their Engineer for Northeast entrance. Detailed plans and estimates will follow in ten days with explanatory letter. Board Consider that the Secretary of State should be asked by wire immediately to postpone sanction to any design for entrance pending receipt of Board's proposals which will allow work to proceed for a time at both arms on the revised sanctioned design published with G.O. 3127 Works nineteenth December 1884.

/True Copy/

C Grimwood

Secretary
Harbour Trust

EXTRACT of Proceedings of the TRUSTEES of the HARBOUR of MADRAS, at a Meeting held at the Offices of the Board on Friday the 12th day of October 1888.

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× × ×

2. Read and discussed draft of letter from the Chairman to the Chief Secretary to Government Marine Department, embodying the views of the Trustees upon their Engineer's report on the question of the Harbour Entrance.

Approved unanimously as amended.

× × ×

/True Extract/

C Swinton

Secretary
Harbour Trust Board.

Gn. I. Home No. 997/88

Gen. S. Inwards No 9971 dtd

EXTRACT of Proceedings of the TRUSTEES of the HARBOUR of MADRAS, at a Meeting held at the Offices of the Board on Friday the 5th day of October 1888.

176

× × ×

2. Read letter from the Engineer Harbour Trust Board № 909 dated 1st October 1888, forwarding and explaining in detail, plans and estimates called for in G.O. № 2335 dated 1st August 1888.

Mr. Lee Pegon was present and further explained after giving the Trustees such additional information and explanations as were required.

Resolved unanimously that the Engineer's plans for a North East Entrance "№ IX A" be approved, and that the Chairman be invited to address Government.

Resolved further that the following telegram be despatched to Government.

Referring to G.O. number 2335 Works, 1st August 1888, the Bo

have Considered proposals submitted by the Engineer for a Northeast Entrance. Plans and estimates will follow in the Corps with explanatory letter. Board consider that the Secretary of State should be asked by wire immediately to treat some sanction to any design for entrance, pending receipt of Boards proposals which will show work to proceed for time, at both arms on the revised lines approved design published with G.O. 612 Works 15th December 1887. Proposed by Mr Best, seconded Captain Hunt and Carried unanimously, that the Chairman convey to Mr. A. de Rozario the thanks of the Board for the very able and clear manner in which he has submitted his report, proposals, and estimates for the Northeast Entrance to the Harbour.

Vice Retired-1

President

Secretary
Harbour Trust Board.

Harbour Trust Board Office,

MADRAS, 9th October 1888.

No. 2688-

From R. W. Barlow Esquire C.S.

Chairman, Harbour Trust Board,

MADRAS,

To

J. F. Price Esquire C.S.

Acting Chief Secretary to Government,

Marine Department.

Fort Saint George.

Sir

I have the honor to acknowledge the receipt of G. O. No. 2335-W Public Works, dated 1st August 1888, and to submit herewith for the information of Government, Copy of letter No. 909 dated 1st October 1888, from the Boards Engineer, furnishing all details that the late Superintendent has left on record with regard to No. III design, and further forwarding his report, plans and estimates, for carrying out a modification of plan IV; also Copy of a Resolution passed thereon

by the Trustees, at their meeting of
[illegible] in accordance with which
a telegram was despatched to you
that evening. Copy of which is inclosed
2. You by letter of [illegible] dated [illegible]
[illegible] have informed Government
that the Trustees prefered
plan No II but "any modification
of plan No II or any plan which
will give them a "Wet Dock
water within a reasonable time,
"at a cost which they can
"afford to pay, to all they have
contended for as being absolutely
necessary. The enormous traffic to
be removed to carry out plan No II,
has never until now been clearly
explained to the Trustees, nor has
the great protection the old, partly
submerged, wall will afford to the
new work, ever before been clearly
demonstrated, as has now been
done; in the Crane sections shown
on the plan forwarded herewith,
and the Board are now of
opinion, in view of this very clear

information afforded by their
Engineer, that the danger of
repeated wreckage of dredging
170 plant, and the uncertainty as
to the time of completion, are
fatal objections to Mr Thorowgood's
proposals, although approved by
the Home Committee; who,
however, were not in possession
of the information now placed
before the Board, and only
approved of plan No III on that
grounds.

3. The Trustees observe that
in his note dated 27th June 188[illegible]
the Honorable Colonel Basted
remarks, that "It may possibly
"prove, as the best way of
"completing the harbour expeditiously
"that the Northern arm should
"be nearly completed on the lines
"of the present design, so that one
"Crane could be used in con-
"structing the protecting arm of

the Committee approved plan,
while another is pushing on the
Southern one, but it can hardly
be the most economical plan.
and it should be considered
if this method of working is to be
adopted, whether the section of the
work, which would only have
to stand for a year or two, should
not be modified with a view to
the easy removal of the blocks
as soon as the protecting arm
is completed. The Trust know both
that Mr Pogson's proposals for
carrying this suggestion into effect
would appear to be not only the
most satisfactory, but also the
most economical. I should mention
here, that a sketch of the modifi-
cation of the design of the proposed
completed entrance, No IV A, has been
shown to Sir Guilford Molesworth
by one of the Trustees, Mr Hanna
M.P. & C. how at Leith, and has
met with his entire approval, and

Sir Guilford has authorized me
by wire to use this expression
of his opinion.

4. The Trustees unanimously
approve of Mr. Pogson's proposals
for a North East Entrance, and
prefer his plan to all others that
have come before them - As regards
his remarks at para 27, the Trust
can have no possible objection
to this plan affording as it pro-
gresses, further practical informa-
tion as to what would be the
effect of an Eastern entrance when
completed. If then it is found
that an Eastern Entrance will
not give sufficiently smooth water
the Board are unanimously of
opinion that plan No IV A should
be adopted, if the financial posi-
tion of the Port will admit of it.
Smooth water is essential, and
if they obtain this - as they have
clearly expressed themselves in
their No 69 dated 6th April 1857

the precise plan by which that result can be obtained is a matter of comparative indifference; but the one now submitted seems more likely than any other to effect this economically, by using the debris of the old submerged works, as well as utilizing the shelter afforded by it, and the Board have therefore adopted it, and if Government approve of the Board's resolution, I am desired to request that the matter may be referred to the Secretary of State for sanction, and that his decision may be communicated by wire, so that the Trustees may be in a position to direct Mr Rogers to resume work upon the sanctioned design at the earliest moment, immediately the conclusion of the coming North East monsoon renders active operations practicable.

I have the honor to be
Sir
Your most obedient Servant

C. Rae

W Morrison
Chairman
Barbam

MARINE DEPARTMENT.

From

THE CHAIRMAN,

To

Dated 19th Oct 1888

Received 23rd

Registered

Subject

Submitting for the information of Government report plans and estimates, from the Engineer Harbour Trust Board, with reference to a letter to the Harbour Board, for in G.O. No 2335-W dated 1st August 1888

Ist W. C.R. 10545

Kindly say whether this paper is to await the arrival of H.E. the Governor. It might perhaps be put into type, but not issued until H.E. has approved of the draft?

C.S.
1-11-88

It cannot go to H.E. before it is put into type. So I believe H.E. does not return until the 12th it had better be sent to him by hand

P.W.C. No 10545

The proposals were first framed by the Harbour T.B. on examination of the scheme advised by Mr Parkes, in his letter to the Sec. of State No of 25th Oct. 1887 printed with P.D. No 153 W of 16-1-88

Lt. Smithett Bruce-smith has impressed the Trustees that he approves of design No IV A, and the lines on which the work will be carried out, if sanctioned, are similar to those recommended by Col Hewett in his note of 27th June 1888 printed with P.D. No 2335-W of 1st Aug/88.

My own opinion has been, since the receipt of the report of the London Committee dated 19th Oct by, and Mr Parkes remarks thereon in the letter referred to in the first para of this note, that if a new harbour was to be constructed on this Coast, the entrance should be to the N.E, on account of the certainty of obtaining smooth water for the greater portion of the year,

P.W.C. No 10545

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The two proofs were first
forwarded by the Harbour T.B,
one on elaboration of the
scheme advised by Mr Sarkies,
in his letter to the Sec. of State
for of 25th Nov. 1907 printed
with Pro No 153 W of 16-1-08
Lt. Fruitfoot Bolesworth has
informed the Trench that he
approves of design No II A,
and the lines on which the
work will be carried out,
if sanctioned, are similar
to those recommended by
Col Hanbidge in his note of
27th June 1908 printed with
Pro No 2335 W of 1st Aug/08.
My own opinion has been,
since the receipt of the
report of the London
Committee dated 19th October,
and Mr Sarkies remarks
thereon in the letter referred
to in the first para of this note,
that if a new harbour was
to be constructed on this
Coast, the entrance should
be to the N.E, on account
of the certainty of obtaining
smooth water for the
greater portion of the year,

such as there is no doubt on record to shew the actual section of work that will withstand the heaviest seas on this coast, I think it would be a most unwise step to adopt in the re-construction of the harbour, any entrance that will necessitate the removal of the old existing work, unless it is proved by actual experience that such a step is a positive necessity; as in other words, that some of the old work must come up & make an opening to the N.E.

The sections on the Engineer's plans No IV A will shew where this required work is, it is all connected together with a solid mass, and I know as a fact that Mr Brownfield buttress are strong chains ½" I believe, in attempting to separate his blocks, that were mainly lying against each other, when dispositions put into the old work;



and it is beyond doubt that the old required work

1857

will form a most valuable protection to the new work which is proposed to be built behind it, & this at the point where the heaviest seas have to be met.

The question as to the necessity absolutely, & on the position comparatively to be left, until it is found that an Eastern entrance renders the harbour to resort of ships. and then if it is found to be the resort of ships in stormy weather (the harbour is never intended to be a place of refuge) the question of an inner harbour for lighters & boats can be taken up

If work proceeds on the lines of design No IV A. the harbour will in 2 yrs 10 m from date of commencement of work, or the above design, have an Eastern entrance 577 feet wide; and the total cost will be £ 41,47,904

These figures do not of course include the expenditure on the original design that failed in 1851, this amounted to £ 65,55,939 and must be added to sums of the proposed ones made to get the total cost of the harbour.

Considering that the whole question of the best form of entrance is undetermined, the proper plan on which to proceed is that which will cost least, and give the most reliable data for future operations, and Capn Le R must bear these conditions.

If the Govt of Natal will sanction the re-commencement of the works on the lines of Plan IV A there need be no more delay questions about the best theoretical position for the entrance, for on the Harbour Board's completion with an eastern entrance, there will be ample evidence to prove whether an opening to the N.E. is necessary or not, & if it is necessary none of the work carried out according to plan IV A will have been wasted.

At this stage there is no object in bothering up the question of the best harbour.

In 3 years from 1st Jany. 89 the Harbour Board ought to be in a position to say, whether an Eastern entrance is desirable or not; they cannot I am convinced give any definite opinion now that would be of any

1884

Note by the Chief Engineer

In G.O. No. 3259 dated 13th October 1882 a telegram was ordered to be sent to the Secy of State informing him that the Madras Harbour Board requested him to defer orders pending receipt of detailed plans and estimates and further that apparently the Harbour Board were coming round to para 36 of Mr. Parkes letter of the 25th Nov. 1881.

2. The detailed plans and estimates with Report have been now received from the Harbour Board and an inspection of them shows that the plan is practically No 4 or the one preferred to and recommended as A by Mr. Parkes in letter (paras 30 & 35) printed in G.O. No 153 W of 16th January 1883 and also the Board prefer

to

to carry out the Parkes
suggestion (for groyne 23 and 24
to artificially restore the
harbour to its state on
which it was previous
to the storm of 1887
leaving the whole of
the shingle bank which
to be pulled down after
a breach will be made from
the depot should it be
found advisable in order to
to obtain sufficiently
extensive waterway in the
harbour; funds to
this end be done without
any engineering difficulties and during the
period of alteration from
the Eastern to the Western
Pier entrance the harbour
will be sufficiently safe
used before the storm of
1887, as the opening to the
sea will not be less
than 150 feet at the
narrowest part of the
proposed new channel
greater portion of which

of

185

of the old work is obliged
and it is believed that
although the committee
of 1887 preferred an Admiralty
pounds plan (Parkes's)
Mr. Parkes tells) it is
believed that there are
no objections to Plan A
(the one practically now
proposed by the Harbours
Board) on these
grounds, and it is con-
sidered an engineering
grounds both by Mr. Parkes
and the Harbours Board
believed by Sir J. Molesworth)
the best and cheapest
it is considered that
the plans, estimates
and Report together with
the letter from the Chairman
of the Madras Harbour
Trust should be sent to the
Secy of State for consideration
tion and for final de-
cision with a request
that the decision may
be given as soon as
practicable, as it is of
the utmost importance

that

1888 regarding the Madras Harbours we have the honour to forward a letter from the Harbour Trust Board submitting their detailed proposals with plans and estimates for completing the Madras Harbours.

2. It will be observed that the Harbour Trust Board prefer on Engineering grounds a form of entrance based on Plan No. II in the Report of the Committee of 1887 or Plan A in Mr. Parkes' letter of the 25th Nov. 1887 and proposed to carry out the work according to Mr. Parkes' suggestion made in paras 30 to 34 of his letter referred to above; that is, virtually to restore the harbours with an Eastern entrance to the state it was in previous to the storm of November 1884. Should it then be found, as in our opinion will be the case, that the Eastern entrance does not prove sufficiently smooth water, the North East entrance can be forthwith gradually constructed without serious engineering difficulties, and

× Vide Despatch from the Secretary of State No. 11 Public Works dated 15th December 1887

and during the period of alteration from the Eastern to the North East entrance the usefulness of the Harbours will be in no way impaired.

3. The proposals of the Harbour Trust Board are clear and appear to contain all the information necessary to enable Your Lordship to arrive at a decision as to the manner in which work on the Harbours should now be resumed; and we would point out that although the Committee of 1887 preferred plan No. III on nautical grounds, we believe that no exception on such grounds can be taken to the new Plan No. III A, while the arguments in favour of its adoption, on Engineering grounds, are very strong.

4. In conclusion, we would ask that Your Lordship's decision may be communicated to us by wire, as it is of the greatest importance that none of the next working season should be lost.

I have &c.

30.10.88

30/10/88

as to the preliminary steps of restoring the Harbours with an Eastern entrance

P.W. Department

No 3665/1891 Forty

To

The Secretary to the
Govt. of Madras
P.W. Dept

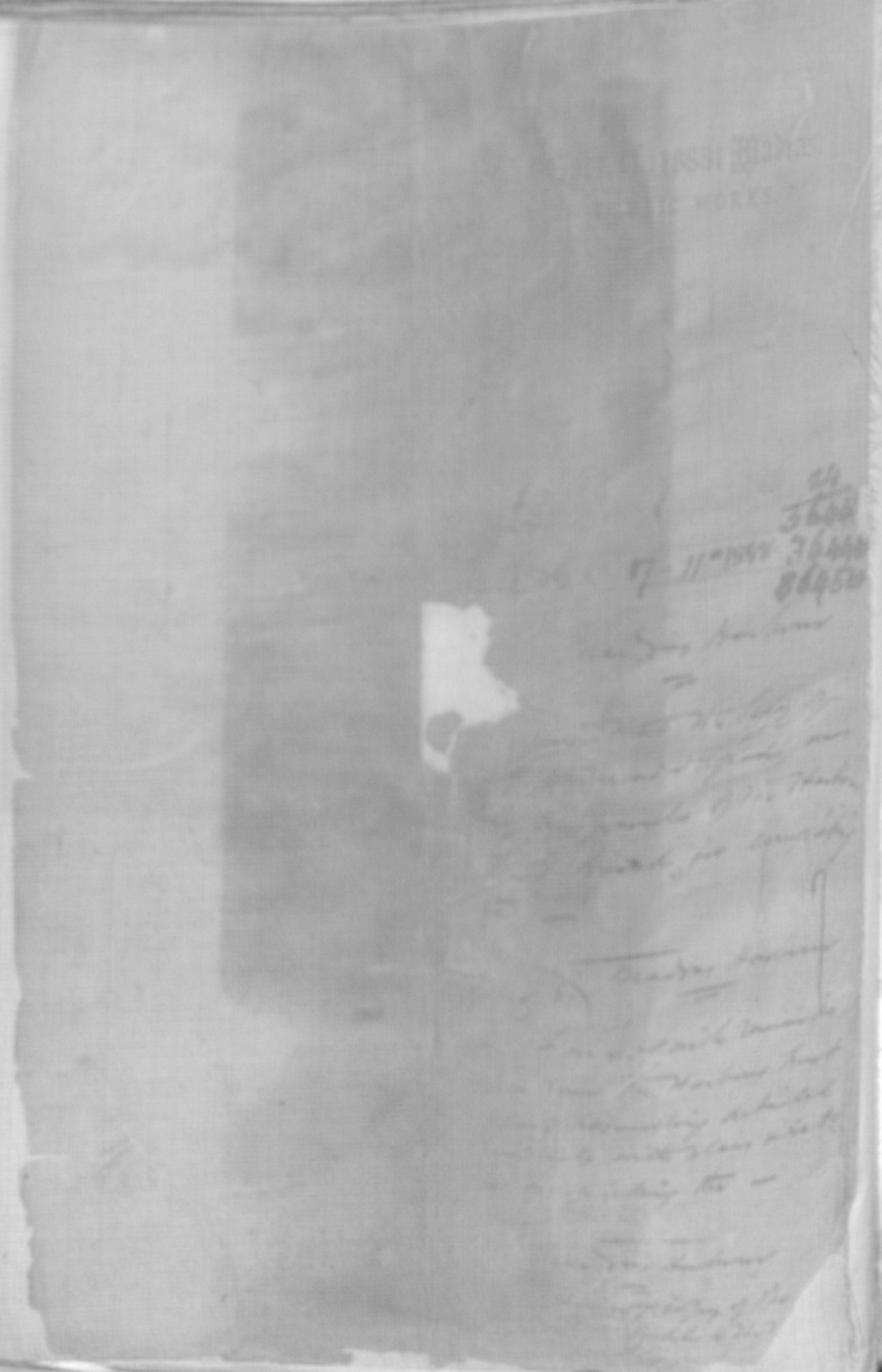
Sir

I am directed to forward herewith for the information of the Government of Madras a copy of the Proceedings of the Government of India dated 17th Nov 1888 together with copy of the Despatch to the Right Honorable the Secretary of State submitting proposals for the completion of the Madras Harbour Works

I have &c

30.10.91 30/10/91

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Note by the Chief Engineer

1884

In G.O. No 3259 dated 15 October 1883 a telegram was ordered to be sent to the Secy of State informing him that the Portland Harbour Board requested time to defer ordering sending receipt of detailed plans and estimates and further that apparently the Harbour Board were coming round to para 56 of the letter of the 25th Nov. 1882

2. The detailed plans and estimates with Report have been now received from the Harbour Board and an inspection of them shows that the plan is practically that which was referred to and recommended as A by the Parties in letter (paras 56 to 58) printed in G.O. No 153 W of 16th January 1883 and also the Board do prefer

to

of the old 2 months it only stands
and it is believed that
although the foundations
of 1887 proved an excellent
foundation than had before
been the case it is
believed that there are
no objections to Plan A
(the one practically now
proposed by the Harbour
Trust Board) on these
grounds, and it is con-
sidered on Engineering
grounds both by Mr. Parkes
and the Harbour Trust
Board (and also it is
believed by Sir G. Molesworth)
the best and cheapest
it is considered that
the plans, estimates
and Report together with
the letter from the Chairman
of the Madras Harbour
Trust should be sent to the
Secy of State for considera-
tion and for final de-
cision with a request
that the decision may
be given as soon as
practicable, as it is of
the utmost importance
that

to carry out the Parkes
Suggestion (See paras 22 and 23
to materially restrict the
harbour to the shade and
which it was provided
in the Estimate of 1887
leaving the question of
the utmost land reclamation
to be settled hereafter
which will be more from
the deposit should it be
found advisable in order
to obtain sufficiently
sheltered anchorage in the
harbour for the
entrance could then
also be done without
any engineering difficulties
and during the
period of alteration from
the Eastern to the Central
East entrance the harbour
will be sufficient as it
was before the storm of
1881, as the opening to the
sea will not be less
than 500 feet which
should open the plan
proposed so that the
smaller portion of Arbuthnot

of

1888 regarding the Madras Harbours we have the honor to forward a letter from the Harbour Trust Board submitting their detailed proposals with plans and estimates for completing the Madras Harbours.

2. It will be observed that the Harbour Trust Board prefer an Engineering Scheme of entrance based on Plan II taken in the Report of the Committee of 1887 or Plan A in Mr. Parkes letter of the 25th Nov 1887 and proposed to carry out the work according to Mr. Parkes suggestion made in paras 30 to 34 of his letter referred to above; that is, virtually to restore the harbours with an Eastern entrance to the state it was in previous to the storm of November 1881. Should it then be found, as in our opinion will be the case, that the Eastern entrance does not give sufficiently smooth water, the North East entrance can be formed without serious engineering difficulties, and during the period of alteration from the Eastern to the North East entrance the usefulness of the Harbour will be in no way impaired.

3. The proposals of the Harbour Trust Board are clear and appear to contain all the information necessary to enable Your Lordship to arrive at a decision as to the manner in which work on the Harbours should now be resumed; and we would point out that although the Committee of 1887 prepared plan No. III on nautical grounds, we believe that no exception on this account can be taken to the new Plan No. II A, while the arguments in favour of its adoption, on Engineering grounds, are very strong.

4. In conclusion, we would ask that Your Lordship's decision may be communicated to us by wire; as it is of the greatest importance that work of the next working season should be lost.

I have &c.

30.10.88 30/10/88

× Vide Despatch from the Secretary of State No 11 Public Works dated 15th December 88

as to the preliminary steps of restoring the Harbour with an Eastern entrance

P.W. Department

No 3645/1890 Records

To

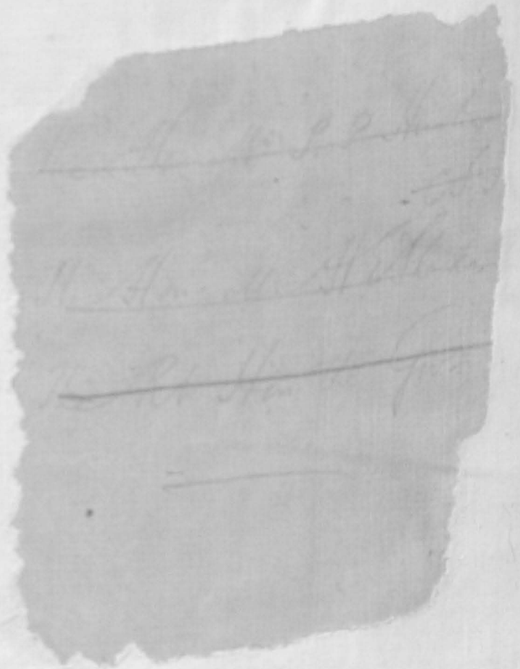
The Secretary to the
Govt. of Madras
P.W. Dept.

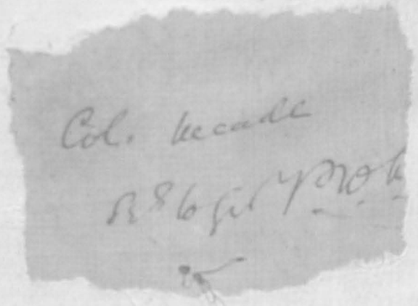
Sir

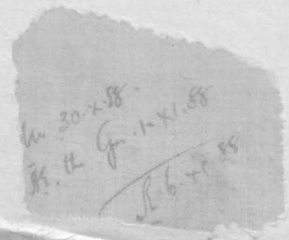
I am directed to forward herewith for the information of the Government of Madras a copy of the Proceedings of the Government of India dated 17th Oct 1888 together with copy of the Despatch to the Right Honorable the Secretary of State — submitting proposals for the completion of the — Madras Harbour Works.

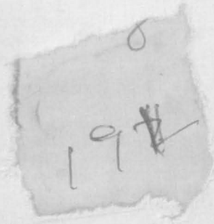
I have &c

30.10.88




Col. Meade
886 fol 1 No 6


Va. 30 x 58
Ky. 11 Gr. 1 x 1. 58
Fl. 6 x 58


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194

that the Harbour Works should be proceeded with as soon as practicable—

4. It is not thought necessary at present to discuss the question of the proposed site for an inner harbour; this can lie over until the harbour is completed as it was previous to 1881 and until the question of Eastern or North East entrance is decided after trial.

W. R. Rumbold Lt. Col.
Actg Chf Engineer

Public Works Department.

PROCEEDINGS OF THE MADRAS GOVERNMENT

Under date the

Read the following

From the Chairman A.S.I. Board Madras. No. 2685 dy 19th Oct 1888.

Endorsement " dy 24th Oct, 1888.

From Marine Dept.

The Right Honble the Governor in Council resolves to submit the papers forwarded by the Harbour Board to the Secy of State for decision. The plan proposed is in accordance with Mr Parkes ~~suggestions~~ and merits much consideration.

Ordered that the Secy of State be addressed.

(A.G. No 3464 to dy)

To The Right Honble
The Secy of State for India
London

My Lord,

In continuation of our despatch dated the 1st August 1888

...ion regarding the Madras
Harbours we have the honour
to forward a letter from the
Harbour Trust Board sub-
mitting their detailed proposals
with plans and estimates for
completing the Madras
Harbours.

2. It will be observed that
the Harbour Trust Board
prefer an Engineering scheme
of a form of entrance based
on Plan No. III of the Board of
the Committee of 1877 which
is the Port Officer's proposal
as regards the Port Blair's suggestion
and the Harbour Board to the of
this letter referred to above,
that is virtually to restore
the harbour with an Eastern
entrance to the state it was
in previous to the storm of
November 1881. It would then
be found, as in the opinion
will be the case, that the
Eastern entrance does not
afford sufficient smooth
water, the North East entrance
cannot be constructed
can be formed without serious
engineering difficulties,

and

Sir Ref. to Secretary of State's letter No. 2 dated 18th Jan. 1882

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and during the period of
alteration from the Eastern
to the North East entrance
the usefulness of the Harbour
will be in no way impaired.

3. The proposals of the Harbour Trust Board are clear and appear to contain all the information necessary to enable Your Lordship to arrive at a decision as to the manner in which work on the Harbour should now be resumed; and we would remark that although the point of the Committee of 1877 prefer Plan No. III on nautical grounds, we believe that no exception on this ground can be taken to Plan No. II A, while the arguments in favour of its adoption, on Engineering grounds, are very strong.

4. In conclusion, we would ask that Your Lordship's decision may be communicated to us by wire; as it is of the greatest importance that work of the next working season should be carried on.

I have &c.

W. M. 30.10.82

30/10/82

as to the preliminary steps of restoring the Harbour with an Eastern Entrance

P.W. Department

No 3664 dated 17th Nov 88

To

The Secretary to the
Govt. of India
P.W. Dept.

1890

Sir.

I am directed to forward herewith for the information of the Government of India a copy of the Proceedings of this Government No 3644 dated 17th Nov 1888. together with copy of the Despatch to the Right Honourable the Secretary of State submitting proposals for the completion of the Madras Harbour Works.

I have &c

30.10.88

30/10/88

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194

