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TAMIL NADU ARCHIVES

GOVERNMENT OF TAMIL NADU

Public Works DEPARTMENT

G.O. No. / P.P. No: 2861	Press. / Mis.
Dated 11-X-1883	198

Not to be folded or roughly handled

GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

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Buildings and Roads.
Civil Works.

READ again—

G.O., dated 22nd September 1883, No. 2662 W., Public Works.

Read—the following letter from the Government of India, dated 6th September 1883, No. 341 M. :—

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

ENCLOSURE.

Note on letter from the Government of Madras, No. 1856 W., dated 4th July 1883, and enclosure, being Report of Committee to consider the question of restoration of the Madras Harbour Works.

The recommendations of the Committee seem to me to be both sound and practical, especially in respect to the closing of the present eastern entrance and making another at the north-east angle. I am inclined to agree with Mr. Beardmore, however, that it would be an advantage to carry the protecting spur at the entrance somewhat further out than the Committee propose. It is said in the report that the heaviest seas yet observed have invariably been from the north and north-east (paragraph 31), and also that the angle of deviation from a line parallel to the coast of the swell which unceasingly beats on the shore is believed in no case to exceed 30° (paragraph 29). I see that the spur is of such length as just to block the entrance of waves approaching at the latter angle. I cannot help thinking it would be better, in order to meet a north-easterly sea, to run the spur out about 350 feet further, in the way indicated in pencil on the map. There may be objections to such a prolongation, apart from the additional cost it would involve, of which I am ignorant, but it would certainly give a protection to the entrance and the interior of the harbour much greater than the shorter spur would afford.

As Mr. Molesworth has made a study of these harbour works, he will perhaps kindly favor Government with his opinion on these proposals.

12-7-83. W. S. T.
Consulting Engineer.

In the following remarks I propose, for the sake of brevity, to term the Committee appointed by the Secretary of State in July 1882, and consisting of Sir John Hawkshaw, Sir John Coode, and Professor Stokes, the "*Home Committee*," whilst I shall term the Committee appointed in Madras on the 30th of April 1883 the "*Madras Committee*."

The recommendations of the Home Committee may be dealt with under four separate heads—

First.—The raising of the height of the breakwater from 6 to 12 feet above high water level.
Second.—The strengthening of the sides of the harbour.
Third.—The reconstruction of the elbows and faces of the harbour.
Fourth.—The question of the entrance to the harbour.

To deal with these *seriatim*—

First.—I am of opinion that the raising of the height of the breakwater is desirable, and that it will contribute greatly to the preservation of still water within the harbour in times of rough weather.

It appears to me, however, to be unnecessary to raise the level of the breakwater, except on the faces and elbows; for, as I have already pointed out in my previous report on the Madras Harbour, the *sides* of the harbour will probably never be exposed to the broadside action of cyclonic waves; and this opinion is confirmed in the report of the Madras Committee, which states that "*no matter what the direction of the wind, the unceasing swell on this portion of the coast rolls in with*

the crests of the waves parallel or nearly so to the coast," nor can it, I think, be otherwise; and the heavier the swell, the greater is the tendency to assume the direction above described. Moreover, if the proposal of the Madras Committee respecting the entrance be adopted, the north side will be still further protected from wave action.

I would therefore suggest a postponement of the raising of both sides of the harbour until further experience has been gained as to the necessity for the work. The raising may be executed at any time; it is not a work that presses; and does not form an integral portion of the reconstruction; and if it be postponed, valuable experience will be gained as to its necessity during the period of reconstruction.

I think, however, the cost of raising the sides might be retained in the estimate as a contingency to which Government may be liable.

The raising of the faces and elbows might be carried on simultaneously with reconstruction.

Second.—The reasoning which I have applied to the raising of the sides will also hold good to a certain extent with regard to the strengthening of the sides by random blocks thrown down on the sea side to form a "wave-breaker," for I am induced to think that it will not be necessary to adopt so large a provision as that contemplated in the report of the Home Committee.

In my previous report I suggested that the sides should be protected by throwing down additional gneiss rubble on the sea side, and I am inclined to think that this will suffice. I should at all events be disposed *at first* to lay down not more than a few hundred feet of "wave-breaker" at that portion of the side which is nearest to the "elbow," and additions may be made to this at any time should it be found necessary.

I should be disposed, therefore, as in the case of raising the sides, to postpone the execution of this portion of the works, whilst retaining it in the estimates.

Third.—The Home Committee has suggested for the reconstruction of the faces and elbows three alternative propositions, viz.:—

(*a*) Replacing the fallen blocks in their original position, and adding random blocks as a "wave-breaker."

(*b*) Constructing a new wall 60 feet in the rear of the original wall, and adding a "wave-breaker" of random blocks.

(*c*) Depositing random blocks on the *debris* of the original wall.

Alternative (*a*) is recommended, *if practicable*; but some doubts are thrown by the Home Committee upon the practicability of the plan. The Madras Committee also expresses strong doubts as to its practicability, which I must admit I share; and even assuming its practicability, the Madras Committee considers that it must be attended with very great difficulty and delay, and should on that account be rejected, narrowing down the selection to alternatives (*b*) and (*c*).

Alternative (*b*) is quite practicable, but the Home Committee points out that it will shorten the harbour (already very short), and that it will be undesirable to build on the unconsolidated rubble.

In addition to the objections raised by the Home Committee, I am of opinion that the *debris* of the original wall, irregular as it is, and being in advance of the new wall, would probably set up a very serious wave action of which it is impossible to predict the results. In some places the wall stands to its full height, whilst in other places there are breaches, and the only way of obviating a complicated wave action would be thoroughly to dismantle the old wall and reduce it to an even surface; and this would be a very expensive operation.

Alternative (*c*) "*possesses*" (in the opinion of the Home Committee) "*advantages, and, as regards construction, is a safe system to follow.*" It is objected to only on account of necessitating short walls at its extremities for entrance lights, and on the ground of admitting through its interstices some disturbance inside the harbour. The Madras Committee, however, points out with much force that these objections are not valid. The entrance lights are not needed, and, even if they were needed, could be arranged for otherwise; and the core formed by the old wall would prevent disturbance in the harbour through the interstices of the random blocks.

The Madras Committee then, considering that there is "no valid professional objections" to the random block system of construction, give a decided preference to alternative (*c*), and with this opinion I entirely concur.

I think, however, that the section proposed needs some slight modification. It is well known that if a wave be deflected, its force will be far less than if it be allowed to break; and waves will be broken by any slope having an inclination less than 1 to 1; whilst from that angle to the perpendicular the wave will not be broken, unless it be nearly on the point of breaking when it reaches the slope. Now the section proposed averages about an inclination of $1\frac{1}{2}$ or $1\frac{3}{4}$ to 1, and on such a surface the waves will probably break instead of being deflected. Nearly all the French breakwaters constructed on the random block system have an average slope of 1 to 1, and I recommend the adoption of that slope in the section to be given to the face and elbows of the Madras breakwater when reconstructed. The same reasoning holds good as regards the rubble deposit, which is shown on the section, at an average slope of about $3\frac{1}{2}$ to 1.

The adoption of this slope would give a tendency to convert vertical into horizontal motion, and make the waves to break heavily on the breakwater. The lower portion of the wave being restrained, the upper part would be flung heavily on the breakwater. I would suggest that

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no additional rubble should be placed on the outside of the section, but that the blocks should be allowed to fill up any deficiencies in the section; this would not entail any larger expenditure of blocks than is at present contemplated, if the French practice of slopes of 1 to 1 be followed; and the section would be safer from disturbance.

I think that the fact that the rubble has been displaced by the wave action shows the necessity for extending the casing of large blocks to that depth.

I enclose typical sections (diagram Nos. 1 and 2) which I recommend as modifications of those which accompany the report of the Madras Committee.

Fourth.—The Home Committee suggests the reduction of the entrance from 550 to 450 feet in width, whilst those who have had actual experience in working vessels in and out of the harbour consider that this will render the entrance "difficult and dangerous to a degree out of all proportion to any advantage that can be gained by it;" and although, from a study of the comparison with other harbours, I am inclined to think that a reduction might be made in the width of the entrance, yet, in the face of so strong an expression from those who have had actual experience, it would be prudent to defer any reduction of the entrance, as I suggested in my previous report, until further experience has been gained; and I think that if two fixed beacons were placed at each side of the entrance as proposed to be reduced by the Home Committee, the necessary experience might be practically obtained before the time arrives for carrying out the reduction proposed.

There is no doubt that even with this reduction there will be a considerable movement within the harbour.

I have calculated the probable intensity of the swell in the harbour at different distances from the entrance and with waves of different initial height outside the entrance. The following tables give the results of my calculations:—

Table No. 1.

Width of Entrance 550 Feet.			
Distance from Entrance.	Height of Swell in Harbour when Initial Height of Waves outside is		
	25 Feet.	30 Feet.	35 Feet.
	FEET.	FEET.	FEET.
500 feet	7·32	8·78	10·24
1,000 „	6·68	8·02	9·36
1,500 „	6·26	7·51	8·76
2,000 „	5·92	7·10	8·29
2,500 (head of jetty) ...	5·65	6·78	7·90

Table No. 2.

Width of Entrance 450 Feet.			
Distance from Entrance.	Height of Swell in Harbour when Initial Height of Waves outside is		
	25 Feet.	30 Feet.	35 Feet.
	FEET.	FEET.	FEET.
500 feet	6·40	7·68	8·96
1,000 „	5·79	6·94	8·10
1,500 „	5·37	6·44	7·52
2,000 „	5·04	6·05	7·06
2,500 (head of jetty) ...	4·78	5·74	6·69

These results only give the swell caused by that portion of the wave which passes through the entrance, and do not take into account the disturbing effect of any portion of the wave that may pass *over* the structure.

It will be seen then from these tables that with a 30 feet wave outside the harbour the reduction of entrance would approximately reduce the swell at the head of the jetty inside the harbour from 6·78 feet to about 5·74 feet, or in round numbers about 1 foot.

The "Madras Committee," however, has recommended the closing of the present entrance and opening of a new entrance in the north elbow, this entrance being covered by a projecting breakwater curving out from the eastern tangent of this elbow.

The entrance to a harbour at right angles to the general direction of the swell is generally considered to be a very disadvantageous arrangement; for when a vessel is entering such a harbour, half protected by the entrance, and half exposed to the action of a heavy wave, it is liable to be swung round, and strike the entrance before it can recover itself: this is a contingency to which modern vessels from their extreme length are especially liable.

The projecting breakwater proposed by the Madras Committee will allow some distance for a vessel to recover itself under these circumstances, but I think scarcely sufficient. Colonel Trevor, the Secretary, suggests an increase to the length of this projection, and I am of opinion it should be increased not only for covering the entrance, but also in order to allow a vessel to recover itself if struck by a wave when half protected.

I presume that the nautical authorities on the Madras Committee have satisfied themselves as to the practicability of a ship entering the harbour by such an entrance in stormy weather; but I think it would be desirable to refer this question to the highest nautical authorities in India.

Supposing the entrance to be practicable, the change of entrance would doubtless add very greatly to the quiescence of the harbour; but I must confess that I am somewhat sceptical of the *absolute* safety of vessels in Madras Harbour during a cyclone, even under the conditions of having raised the face and elbows and closed the seaward entrance.

Assuming, however, the feasibility of such an entrance, I am of opinion that the form of breakwater proposed for covering this entrance requires some modification. In its proposed form it is open to serious objections, involving, as it does, a re-entering curve which would never stand the blow of a cyclonic wave.

I have, in my previous report, adverted to the confluent action of the waves along the faces and round the elbows of this breakwater, and I annex a diagram (No. 3) showing in black arrows the action of waves on a breakwater such as that proposed by the Madras Committee.

It will be seen by this diagram that the meeting of the confluent waves along the face with those rolling in direct from the sea would set up a very severe action, and the blows on the concave surface at A would be so severe that nothing in the shape of a breakwater could withstand it.

Moreover, the action of the waves would not only be severe on the breakwater, but, as the confluent action would be diametrically opposed to the direct action of the waves rolling in at B, a very turbulent action of the waves would be set up, which would seriously affect the passage of a vessel into the entrance.

I have shown in red the modification I would propose for adoption in case an entrance at the elbow should be approved, the red arrows showing the action of the wave upon it, which would be far less intense than in the previous case. On the other hand, there is an undoubted objection to the modified form in that vessels entering and leaving the harbour would be thrown further into shoal water than in the form proposed; but if this be an insuperable objection, I am of opinion that the idea of an entrance at the elbow must be abandoned, for a concave face in such a position is in my opinion quite inadmissible.

There is another alternative entrance that might be worthy of consideration as offering shelter to the harbour without the objectionable features of either of the foregoing alternatives. This is shown in diagram No. 4 appended to this note, one of the faces being extended so as to cover the existing entrance, and, by demolishing part of the other face, a sufficient width for a free entrance may be obtained.

This would allow an entrance in deep water, and it is doubtful whether it would be more expensive than the plan proposed by the Madras Committee, for the portion E F would be equivalent to filling in the present entrance. The portion F G in diagram No. 4 would be equivalent to the portion D C in diagram No. 3; and the portion H K to be demolished would be somewhat shorter than the portion of the elbow which it is proposed to demolish for a new entrance. On the other hand, the portion F G in diagram No. 4 will be in deeper water than the equivalent portion D C in diagram No. 3.

If there should be a tendency to rapid shoaling to the south, it might be desirable to extend the other face so as to give the entrance to the north instead of to the south; but in this case the extension would have to be rather longer to give an equal cover to the entrance.

3-8-83. G. L. M.

It may be convenient to sum up my opinions on the four suggestions of the Home Committee as follows:—

First.—I recommend that the raising of the faces and elbows of the harbour be accepted, but that the raising of the sides be postponed pending further experience.

Second.—I recommend that the wave-breaker for the sides be only carried out at first for two or three hundred feet from the elbows, and that its completion be also postponed until the necessity for it can be determined.

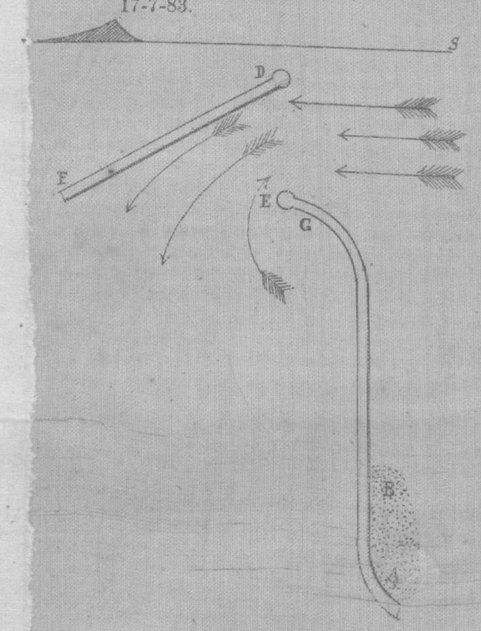
Third.—I recommend the adoption of the random block system on the *debris* of the original wall, but I advise that the sections be modified in accordance with the typical sections given in diagrams 1 and 2 appended to this note.

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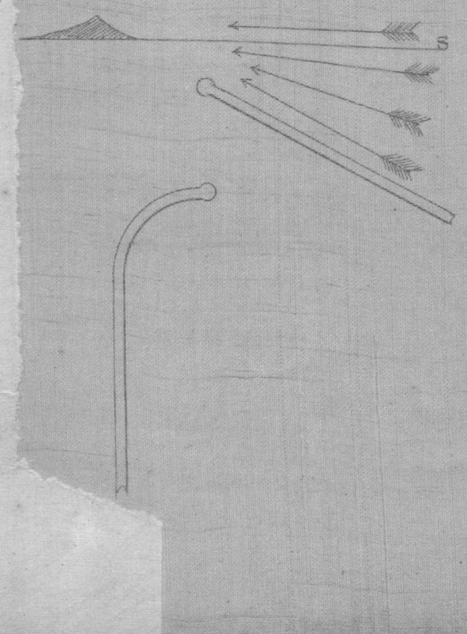
Fourth.—I recommend a postponement of the reduction of the width of entrance until it can be ascertained by practical experiment with fixed beacons that such a reduction can be allowed with safety to the shipping; and with regard to the alternative entrance from one side, I advise that the question be referred to some eminent nautical authority in India, bearing in mind that a concave face to the breakwater is quite inadmissible.

The settlement of the third point, viz., the method of reconstructing the face and elbows, is the only one that presses for an immediate decision, and it is very desirable to arrive at a decision on this point with the least possible delay, not only to enable the manufacture of blocks to be recommenced, but also to prevent further disaster to the existing works from future cyclones by protecting them with random blocks.

17-7-83. G. L. M.



* The current setting *into* the harbour along inner face of F D will tend to heap up the water within the enclosure and generate a current setting *out* at E G.



I have discussed these proposals with Mr. Molesworth personally, and concur in all his proposals. Subject to correction by nautical and local authorities, I think the entrance recommended and illustrated in diagram No. 4 the best yet suggested.

19-7-83. W. S. T.
Colonel Brownlow.

I detained this case, as explained verbally to Secretary and Mr. Molesworth, in order to obtain information regarding the strength, duration, and effect of the littoral currents. In respect to these, see what Captain Taylor says in his letter of July 26th accompanying. Having regard to the greater duration and strength of the northerly current, and especially to what is stated regarding the great quantities of sand carried up from south to north by it, I most unhesitatingly advocate turning the mouth of the harbour to the north instead of the south. A current of 2 miles an hour moves 3 feet in a second, just the velocity of the Ganges canal in its upper reaches, and I am very confident that, with a northerly current of that strength, a very awkward eddy would be generated at E* of sketch in the margin, if the harbour mouth is made to face the south.

This will be very much increased if the current should ever increase to 3 miles an hour, or 4½ feet a second, as it may easily do when the south-west monsoon is blowing strongly, and the danger to ships moving in and out would then be considerable. They could not hug the projecting face F D, as the current would be setting strongly on to it, and thus would be extremely likely to come to grief at E, as the steering would be very uncertain. Besides, when the sand, now being deposited at A B, moves up to the end of the projecting wall, a bar is sure to be formed at E. With the mouth opening to the north the sand would simply travel along the outer side of the projecting face, and would be constantly removed by the same action as that which now tends to cause erosion of the beach to the north of any projection from the beach.

2-8-83. H. A. B.

The currents on the Madras coast are sustained by the monsoon winds and prevailing local winds.

2. Thus, in the latter half of March, when the local long shore winds blow, the current sets to the northward steadily, and at a rate varying from ½ to 1½ or sometimes 2, according to the strength of the wind close inshore and as far out to sea as the observation of coasting vessels reach. This wind continues to blow in April and May, when it becomes merged in the south-west monsoon wind which lasts till September. There is, therefore, a period annually of six and-a-half months during which a current runs to the northward. In October there is little or no current, but on the arrival of the north-east monsoon in November a current from the north sets in and continues through December and January at about the same rate as the south-west monsoon current, ½ to 1½, or in extreme cases 2 miles per hour. February and part of March no current to be detected. The current from the north thus obtains for little more than three months as opposed to six and-a-half from opposite direction. The effect, therefore, is found to be that the sand with which the surf and sea near the shore is charged travels in great quantities from south to north, and is arrested by any projection from the shore and at once deposited, while the clear water passing round the obstruction upon coming again into contact with the beach naturally takes up whatever sand it can find and thus causes erosion. Some partial restoration of this action goes on during the north-east monsoon, but the ultimate proportionate effect is as described. Examples of this are to be found at Covelong, where there is a rocky spit; at the wreck of the *Southern Monarch* at Chepauk; the Madras Harbour Works, and at Pulicat and Armeghon. In the case of the harbour, the action has already led to very great expense in protecting the north beach. Now as there is no considerable rise and fall of tide to expose any mischief that is going on and no daily equal ebb and flow which might repair such mischief, and the current being very searching and the sand easily moved, it follows in my opinion that there will always be danger to any work of the nature of an upright wall, the value of which depends upon maintaining its equilibrium, whereas at Madras sand is the first and chief element of foundation. We have in fact one unequal tide throughout the year, instead of two equal ones daily as in England and elsewhere.

26-7-83.

J. H. T.

I quite agree with Colonel Brownlow as to the desirability in this case of turning the opening to the north instead of the south, but I am of opinion that the northern entrance will require rather greater prolongation than that which has been shown for an opening for the entrance to the south.

3-8-83.

G. L. M.

It might perhaps be as well to add, to my original note, the remark which I have marked in red. (See marginal note facing diagram No. 4.)

3-8-83.

G. L. M.

I do not think the current can possibly carry sand in any sensible quantities beyond the range of the surf. In 8 fathoms of water it would require very heavy seas indeed to stir up the sand at the bottom, and without such stirring up there would be no sand in suspension for the current to carry. Inshore, *i.e.*, within the range of the surf, I have no doubt that the waves and current combined cause a considerable movement of sand, and by degrees the foreshore will probably be advanced seawards by this process, and may in time get to the head of the harbour itself. But this must be a slow advance at best.

However, it would be prudent to make the opening on whichever side is least liable to be encroached upon, and if this be the north, the entrance should be at the north-east angle. We may send Mr. Molesworth's note to the Secretary of State.

3-8-83.

Honorable Member.

W. S. T.

I think that, before reporting to the Secretary of State, it would be only fair to send the notes to Madras for any remarks the Committee wish to offer. To close the front entrance seems the only way to make the harbour even moderately useful, but it will be a nasty place to take a ship into from either side. At the same time, I would sooner take a ship in from the north (considering that she would be ordinarily head to the prevailing winds) than from the south.

9-8-83.

T. C. H.

Civil Works Branch.
10-8-83.

W. S. T.

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

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

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

(True Extract.)

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

READ also—

Report of the Committee appointed in G.O., No. 1259 W., dated 30th April 1883, *and re-assembled under instructions conveyed in G.O., No. 2662 W., dated 22nd September* 1883.

The Committee re-assembled under G.O., No. 2662 W., dated 22nd September 1883, to consider the notes received from the Government of India on their former report, have the honor to submit the following remarks.

2. The recommendations made by Mr. Molesworth are summarised as follows:—

"*First.*—I recommend that the raising of the faces and elbows of the harbour be accepted, but that the raising of the sides be postponed pending further experience.

"*Second.*—I recommend that the wave breaker for the sides be only carried out at first for two or three hundred feet from the elbows, and that its completion be also postponed until the necessity for it can be determined.

"*Third.*—I recommend the adoption of the random block system on the débris of the original wall, but I advise that the sections be modified in accordance with the typical sections given in diagrams 1 and 2 appended to this note.

"*Fourth.*—I recommend a postponement of the reduction of the width of entrance until it can be ascertained by practical experiment with fixed beacons that such a reduction can be allowed with safety to the shipping; and with regard to the alternative entrance from one side, I advise that the question be referred to some eminent nautical authority in India, bearing in mind that a concave face to the breakwater is quite inadmissible."

And an alternative proposal for covering the entrance to the harbour was made, which subsequently Mr. Molesworth amended in accordance with a suggestion by Colonel Brownlow.

3. Considering these recommendations in order, the Committee would only remark with reference to (1) that it appears to them no disadvantage that the sides of the harbour should be kept low, as the tops of the waves which would spill over into the harbour would be clear water which would mix with the otherwise stagnant water within the harbour and cause an outward flow to sea through the entrance.

4. With regard to (2) the Committee are satisfied that the wave breaker is necessary to the whole of the north side. The circumstances of the north and south side are very dissimilar, while the latter is comparatively sheltered during storms and is causing an accumulation of sand on the sea side, the former is exposed to the first effort of the storm in the north-east monsoon and is not protected by any outside bank. The necessity for some further outside protection is now apparent for, although since the storm of November 1881, some 5,000 tons of large gneiss rubble have been tipped as foreshore, yet the centre joint continues to open although the work has not been heavily attacked since the above date. Bearing this in mind the Committee would recommend the construction of the wave breaker on the north side as one of the first things to be done.

5. In the despatch of the Secretary of State which was communicated to the Committee with G.O., No. 1259 W., dated 30th April 1883, it was stated that the views of the Home Committee should be accepted as closing the discussion on the

principle of restoration to be followed, the Committee therefore framed their estimates according to the sections which were designed by the Home Committee. They would only remark with reference to (3) that experience has shown that the rubble base will not stand at a slope of 1 to 1.

6. As regards recommendation No. 4 the Committee feel very strongly that the northern entrance suggested by them is the only satisfactory arrangement. Attached to this report is a letter from the Master Attendant forwarding the opinions of some of the commanders of the large steamers using the port, the best nautical opinions that can be obtained. It will be seen that all agree in considering the present entrance should be closed and that the northern entrance proposed would be the best that could be designed.

7. It appears to the Committee that there can be no question regarding an entrance on the sea face with a protecting arm to the south. Colonel Brownlow has adduced arguments against it which have been accepted by Mr. Molesworth and which may be considered conclusive.

8. An entrance on the sea face with a protecting arm to the north is, in the opinion of the Committee, open to serious objection, and is not to be compared with the proposed entrance at the north-east corner. In the first place the sea would still during the north-east monsoon set into the harbour and create a swell which one of the principal objects of the Committee's proposals is to avoid.

Secondly.—An entrance on the sea-face would curtail the deep water space within the harbour which could be taken the fullest advantage of with a northern entrance.

Thirdly.—Such an entrance would involve the very difficult task of dismantling and removing the strongest and most deeply founded portion of the whole northern wall, whereas the entrance proposed by the Committee only entails the clearing away of that portion of the work that is already shaken to its very foundation, and is now the most ruined part of the whole structure.

9. As regards the form of the protecting arm or horn the Committee would observe that the slightly curved form proposed by them was adopted after due consideration, as will be seen by reference to their first report, and while allowing the objection raised by Mr. Molesworth to any re-entering angle on the face of the work, they consider that the arm might be made sufficiently strong to resist any action that may be expected. It would in fact be possible by increasing the block protection on the concave side of the curve, to make the outward face an almost direct continuation of the face wall at no very serious additional cost.

10. The proposed shape of the protecting arm to the northern entrance given by Mr. Molesworth, would tend to force ships entering and leaving harbour into shoal water, and any such tendency is to be avoided, though during the north-east monsoon when there might be some difficulty in entering, it is to be noticed that the effect of the northern arm is to create an outward set from the shore to the extremity of the harbour, which would make the lee shore less to be feared than it proverbially is.

11. The Committee are, however, willing to leave the question of the direction and shape of the projecting arm for future consideration and would not object to some modification of the curve they have proposed. The construction of this arm will be the last part of the work to be done; the eastern entrance will have been closed and the northern entrance opened before it will be proceeded with, and the final settlement of the question may therefore, if desired, be postponed. The Committee, however, consider that the more nearly the entrance can be made to approximate to that proposed by them the more satisfactory it will be found to ships using the harbour.

(Signed) J. O. HASTED, Col., R.E.
(") J. H. TAYLOR, Lieut., R.N.R.
(") T. E. MARSHALL.
(") F. N. THOROWGOOD, M. Inst., C.E.
(") N. St. B. BEARDMORE.
(") C. BOWEN, Major, R.E.,
Secretary.

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Enclosures.

From J. H. TAYLOR, Esq., Lieutenant, R.N.R., Master Attendant, Administrative Department, Madras, to the Acting Chief Secretary to Government, dated 4th September 1883, No. 3607.

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

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

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

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

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

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

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

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

From W. A. BURKITT, Esq., Master, S.S. *Dacca*, to the Master Attendant, Madras, dated 10th August 1883.

I have looked over the plan for reconstructing the Madras harbour, and think it an excellent idea closing up the present entrance, and having the new one at the north-east corner, and when the wall of the breakwater is built higher, we ought to have perfectly smooth water. The harbour ought also to be able to give accommodation to several more steamers, and I do not see why it should not be able to give protection to ships in case of a cyclone,—in fact, the present plan is the first which has caused me to believe in the utility of a Madras harbour.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

ORDER—dated 11th October 1883, No. 2861 W., Public Works.

Ordered that the report of the Harbour Restoration Committee, and the opinions of nautical men by which it is accompanied, be transmitted to the Government of India.

(Here enter No. 2862 W., dated 11th October 1883.)

(True Extract.)

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

To the Superintendent, Madras Harbour Works.
" Marine Department.

Exd. A. F. Goodall.
Spare Copies

2861
/b

BUILDINGS AND ROADS.
CIVIL WORKS.

Govt. of {1883} Madras.

PUBLIC WORKS.

Dated October, 11th

Recd. *Encl.*

G.O., 11th Oct. 1883, No. 2861 W.

OCTOBER.

Restoration of the Madras Harbour

Report of the Committee appointed to consider the question of — on the notes drawn up by officers of the Public Works Department of the Government of India, and the opinions of nautical men on the proposed closing of the east entrance in favor of a northern opening, ordered to be forwarded to the Government of India.

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PUBLIC WORKS DEPARTMENT.

Buildings and Roads.
Civil Works.

LETTER—from

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

Secretary to the Government of Madras,

Public Works Department,

To

THE SECRETARY TO THE GOVERNMENT OF INDIA,

PUBLIC WORKS DEPARTMENT.

SIR,

I am directed to acknowledge the receipt of your letter, No. 341 M., dated 6th September 1883, forwarding, for the remarks of the Madras Harbour Restoration Committee, notes drawn up by officers of the Public Works Department of the Government of India. In reply I am to forward the accompanying report of the Committee on the points referred for their remarks, together with the opinions of nautical men, acquainted with the conditions of the port, as to the proposed closing of the east entrance in favor of a northern opening.

2. His Excellency the Governor in Council trusts that, with the additional information now collected, there will be no further delay in arriving at a speedy decision as to the prosecution of the work.

I have the honor to be,

Sir,

Your most obedient servant,

Major, R.E.,
Under Secy. to Govt., P.W.D.

FORT ST. GEORGE,
11th October 1883.

Exd. A. F. Goodall.
Spare Copies

2861
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BUILDINGS AND ROADS.
CIVIL WORKS.

Govt. of {1883} Madras.

PUBLIC WORKS.

Dated October, 11*th*.

Recd. *Encl.*

11th Oct. 1883, No. 2862 W.

OCTOBER.

Restoration of the Madras Harbour

FORWARDING report of the Madras Committee appointed to consider the question of — on the notes drawn up by officers of the Public Works Department of the Government of India, together with the opinions of nautical men, on the proposed closing of the east entrance in favor of a northern opening.

4TH JULY 1883, No. 1855 W., PUBLIC WORKS.

2861/9

GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

Buildings and Roads.
Civil Works.

READ—the following :—

Report of Committee appointed in G.O., No. 1259 W., dated 30th April 1883, to consider the best means for giving effect to the proposals made for the completion of the Madras Harbour, dated 20th June 1883.

ORDER—dated 4th July 1883, No. 1855 W., Public Works.

The Committee appointed in G.O., No. 1259 W., dated 30th April 1883, to consider the question of the restoration of the Madras Harbour Works, having now submitted their Report, the papers will be forwarded for the orders of the Government of India, and copies furnished for the information of the Secretary of State.

(Here enter No. 1856 W., dated 4th July 1883.)

(True Extract.)

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

To the Superintendent, Madras Harbour Works.
„ Marine Department.
„ Master Attendant.
„ Examiner, Public Works Accounts.

Exd. A. F. Goodall.
Spare Copies

BUILDINGS AND ROADS.
CIVIL WORKS.

Govt. of {1883} Madras.

PUBLIC WORKS.

Dated July, 4th.

Read. *Encl.*

G.O., 4th July 1883, No. 1855 W.

JULY.

Madras Harbour Works

Report of the Committee appointed to consider the question of the restoration of the —, ordered to be forwarded for the information of the Government of India and the Secretary of State.

PUBLIC WORKS DEPARTMENT.

2861/10

Buildings and Roads.
Civil Works.

LETTER—from

COLONEL R. H. SANKEY, C.B., R.E.,
Secretary to the Government of Madras,
Public Works Department,

To

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

SIR,

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Soliciting very early orders,

I have the honor to be,
Sir,
Your most obedient servant,
(Signed) R. H. SANKEY, Colonel, R.E.,
Secretary to Govt., P.W.D.

FORT ST. GEORGE,
4th July 1883.

Exd. A. F. Goodall.
Spare Copies

2861/11

BUILDINGS AND ROADS.
CIVIL WORKS.

Govt. of {1883} Madras.

PUBLIC WORKS.

Dated July, 4th.

Recd. *Encl.*

4th July 1883, No. 1856 W.

JULY.

Madras Harbour Works

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

Public Works Department.

PROCEEDINGS OF THE MADRAS GOVERNMENT.

~~Under date the~~ 28/12

Read the following

Letter from the Govt. of India No. 341 W
d/ 6th Sept. 1883.

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

Order thereon No. 2662 W d/ 22 Sept. 1883.

The notes received with this
letter will be referred for consideration
and remarks to the Committee ap-
pointed on 30th April 1883 to report

on the subject of the restoration of the Madras Harbour Works.

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

(True Extract)

Mant Stewart
Col. R.E.

Secy. to Govt. P.W. Dept.

To
Colonel J.O. Hasted R.E.
with spare copies of enclosures for distribution.

E Ed S.

Enclosure.

Administrative Department.

No. 3607.

MADRAS,
MARINE OFFICE,
4th September 1883.

From
J. H. TAYLOR, ESQ., LIEUT., R.N.R.,
Master Attendant,
Administrative Department,
Madras.

To
THE HONOURABLE E. FORSTER WEBSTER,
Acting Chief Secretary to Government,
Marine Department,
Fort Saint George.

Sir,

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

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

Master Attendant,
Administrative Department.

PENINSULAR AND ORIENTAL STEAM NAVIGATION COMPANY,
S.S. "Parramatta,"
August 1st, 1883.

CAPTAIN J. H. TAYLOR,
Master Attendant, Madras.

DEAR SIR,

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

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

Dear Sir,
Yours faithfully,
(Signed) ARTHUR E. BARLOW,
Commander, P. & O. S. S. "Parramatta."

Madras,
Steam Ship "Shannon,"
Peninsular and Oriental Steam Navigation Company,
5th August 1883.

Captain J. H. TAYLOR, R.N.R.,
Master Attendant, Madras.

Dear Sir,

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

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

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

I beg to remain, &c.,
(Signed) J. S. MURRAY,
Commander of the "Shannon."

B. I. S. N. Coy.'s S.S. "Dacca,"
Madras, *10th August* 1883.

Captain TAYLOR,
Master Attendant,

Sir,

I have looked over the plan for reconstructing the Madras Harbour, and think it an excellent idea closing up the present entrance, and having the new one at the North-East corner, and when the wall of the break-water is built higher, we ought to have perfectly smooth water. The Harbour ought also to be able to give accommodation to several more steamers, and I dont see why it should not be able to give protection to ships in case of a Cyclone, in fact, the present plan is the first which has caused me to believe in the utility of a Madras Harbour.

I am Sir,
Yours obediently,
(Signed) W. A. BURKITT,
Master S.S. "Dacca."

Madras,
Peninsular and Oriental
Steam Navigation Company,
S.S. "Kaisar-i-Hind,"
August 14th, 1883.

Captain J. H. TAYLOR,
Master Attendant, Madras.

Dear Sir,

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

2861/14

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

I am dear Sir,
Yours faithfully,
(Signed) E. G. STEAD,
Commander S.S. "Kaisar-i-Hind."

B. I. S. N. Coy.'s Steam Ship "Booldana,"
Madras, *15th August* 1883.

To
Captain J. H. TAYLOR,
Master Attendant,
Administrative Department, Madras.

Sir,

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

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

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

I have the honor to be,
Sir,
Your most obedient Servant,
(Signed) R. S. TURNER,
Commander S.S. "Booldana."

Madras,
1st September 1883.

Captain J. H. TAYLOR.

Dear Sir,

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

I am,
Dear Sir,
Yours truly,
(Signed) J. DUFF,
S. S. "Duke of Sutherland."

PENINSULAR AND ORIENTAL STEAM NAVIGATION COMPANY,
S.S. "CARTHAGE,"
4th September 1883.

CAPTAIN J. H. TAYLOR, R.N.R.,
Master Attendant, Madras.

DEAR SIR,

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

The proposed alteration of the entrance from its present position to the North-East angle of the Northern arm commends itself to my judgment.

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

Smooth water inside the Harbour.

Increased moving space.

Less liability to accident to vessels entering or leaving the Harbour.

Probably less difficulty to vessels putting to sea in bad weather.

I am,
Sir,
Your obedient Servant,
(Signed) G. N. HECTOR,
Master, S.S. "Carthage."

(True Copies.)

Master Attendant,
Administrative Department.

286/15

Report of the Committee appointed in G. O. No: 1259 W dated 30th April 1883 and reassembled under instructions conveyed in G. O. No: 2662 W dated 22nd September 1883.

The Committee re-assembled under G. O. No: 2662 W dated 22nd September 1883 to consider the notes received from the Government of India on their former report, have the honor to submit the following remarks.

2. The recommendations made by Mr. Molesworth are summarised as follows.

1st — I recommend that the raising of the faces and elbows of the harbour be accepted, but that the raising of the sides be postponed pending further experience.

2nd — I recommend that the wave

wave breaker for the sidesbe only carried out at first for two or three hundred feet from the elbows, and that its completion be also postponed until the necessity for it can be determined.

3rd — I recommend the adoption of the random block system on the debris of the original wall, but I advise that the sections be modified in accordance with the typical sections given in diagrams 1 and 2 appended to this note.

4th — I recommend a postponement of the reduction of the width of entrance until it can be ascertained by practical experiment with fixed beacons that such a reduction can be allowed with safety to the shipping; and with regard to the alternative entrance from one side, I advise that the question be referred to some eminent nautical authority in India, bearing in mind that

that a concave face to the breakwater is quite inadmissible.

2861

And an alternative proposal for covering the entrance to the Harbour was made which subsequently Mr. Molesworth amended in accordance with a suggestion by Col. Brownlow.

3 Considering these recommendations in order, the Committee would only remark with reference to (1) that it appears to them no disadvantage that the sides of the harbour should be kept low, as the tops of the waves which would spill over into the harbour would be clear water which would mix with the other more stagnant water within the harbour and cause an outward flow to sea through the entrance.

4. With regard to (2) the Committee are satisfied that the wave breaker is necessary to the whole of the north

north side. The circumstances of the north & south side are very dissimilar, while the latter is comparatively sheltered during storms and is causing an accumulation of sand on the sea side, the former is exposed to the first effort of the storm in the N.E. Monsoon and is not protected by any outside bank. The necessity for some further outside protection is now apparent for, although since the storm of Novr. 1881, some 5000 tons of large gneiss rubble have been tipped as foreshore, yet the centre joint continues to open although the work has not been heavily attacked since the above date. Bearing this in mind the Committee would recommend the construction of the wave breaker on the north side as one of the first things to be done.

5. In the despatch of the Secretary of State which was communicated to the Committee with G. O.

No:

No: 1259W dated 30th April 1883, it was stated that the views of the Home Committee should be accepted as closing the discussion on the principle of restoration to be followed, the Committee therefore framed their estimates according to the sections which were designed by the Home Committee. They would only remark with reference to (3) that experience has shown that the rubble base will not stand at a slope of 1 to 1

2861/17

6. As regards recommendation No: 4 the Committee feel very strongly that the northern Entrance suggested by them is the only satisfactory arrangement. Attached to this report is a letter from the Master Attendant forwarding the opinions of some of the Commanders of the large Steamers using the Port, the best nautical opinions that can be obtained. It will be seen that all agree in

in considering the present entrance should be closed and that the northern Entrance proposed would be the best that could be designed.

7. It appears to the Committee that there can be no question regarding an entrance on the sea face with a protecting arm to the South. Col. Brownlow has adduced arguments against it which have been accepted by Mr. Molesworth and which may be considered conclusive

8. An entrance on the sea face with a protecting arm to the north is, in the opinion of the Committee, open to serious objection, and is not to be compared with the proposed entrance at the north. In the first place the sea would still during the N.E. Monsoon set into the Harbour and create a swell which one of the principal objects of the Committee's proposals is to avoid.

Secondly

2861/18

Secondly. An entrance on the sea face would curtail the deep water space within the harbour which could be taken the fullest advantage of with a northern entrance.

Thirdly. Such an entrance would involve the very difficult task of dismantling and removing the strongest and most deeply founded portion of the whole Northern wall, whereas the entrance proposed by the Committee only entails the clearing away of that portion of the work that is already shaken to its very foundation and is now the most ruined part of the whole structure.

9. As regards the form of the protecting arm or horn the Committee would observe that the slightly curved form proposed by them was adopted after due consideration, as will be seen by reference to their first report, and while allowing the objection raised by Mr. Molesworth to any reentering angle on the face of the work, they consider that

that the arm might be made sufficiently strong to resist any action that may be expected. It would in fact be possible by increasing the block protection on the concave side of the curve, to make the outward face an almost direct continuation of the face wall at no very serious additional cost.

10. The proposed shape of the protecting arm given by Mr - Molesworth would tend to force ships entering and leaving harbour into shoal water and any such tendency is to be avoided, though during the N.E. Monsoon when only there might be some difficulty in entering, it is to be noticed that the effect of the northern arm is to create an outward set from the shore to the extremity of the harbour which would make the lee shore less to be feared than it proverbially is.

11. The Committee are however willing to leave the question of the direction and shape of the projecting arm for future consideration and would not object to some modification of the curve they have proposed. The construction of this arm will be the last part of the work to be done; the eastern entrance will have been closed and the northern entrance opened before it will be proceeded with, and the final settlement of the question may therefore if desired be postponed. The Committee however consider that the more nearly the entrance can be made to approximate to that proposed by them the more satisfactory it will be found to ships using the Harbour.

2861/19

Eastern

W. Layton

Vide enclosure

F.W. Harrowsmith M. Inst. C.E.

Nath. Beardmore (Vide remarks)

C. Unwin, Major R.E. Secretary

8/22

Print without diagrams

2861/20

Note on letter from the Government of Madras No. 1856 W., dated 4th July 1883, and enclosure being Report of Committee to consider the question of restoration of the Madras Harbour Works.

The recommendations of the Committee seem to me to be both sound and practical, especially in respect to the closing of the present eastern entrance and making another at the north-east angle. I am inclined to agree with Mr. Beardmore, however, that it would be an advantage to carry the protecting spur at the entrance somewhat further out than the Committee propose. It is said in the report that the heaviest seas yet observed have invariably been from the north and north-east (paragraph 31), and also that the angle of deviation from a line parallel to the coast of the swell which unceasingly beats on the shore is believed in no case to exceed 30° (paragraph 29). I see that the spur is of such length as just to block the entrance of waves approaching at the latter angle. I cannot help thinking it would be better, in order to meet a north-easterly sea, to run the spur out about 350 feet further, in the way indicated in pencil on the map. There may be objections to such a prolongation, apart from the additional cost it would involve, of which I am ignorant, but it would certainly give a protection to the entrance and the interior of the harbour much greater than the shorter spur would afford.

As Mr. Molesworth has made a study of these harbour works, he will perhaps kindly favour Government with his opinion on these proposals.

12-7-83. W. S. T.

Consulting Engineer.

In the following remarks I propose for the sake of brevity to term the Committee appointed by the Secretary of State in July 1882, and consisting of Sir John Hawkshaw, Sir John Coode, and Professor Stokes, the "*Home Committee,*" whilst I shall term the Committee appointed in Madras on the 30th of April 1883 the "*Madras Committee.*"

The recommendations of the Home Committee may be dealt with under four separate heads—

1st.—The raising of the height of the breakwater from 6 to 12 feet above high water level.

2nd.—The strengthening of the sides of the harbour.

3rd.—The reconstruction of the elbows and faces of the harbour.

4th.—The question of the entrance to the harbour.

To deal with these *seriatim*—

1st.—I am of opinion that the raising of the height of the breakwater is desirable, and that it will contribute greatly to the preservation of still water within the harbour in times of rough weather.

It appears to me, however, to be unnecessary to raise the level of the breakwater, except on the faces and elbows; for, as I have already pointed out in my previous report on the Madras harbour, the *sides* of the harbour will probably never be exposed to the broadside action of cyclonic waves; and this opinion is confirmed in the report of the Madras Committee, which states that "*no matter what the direction of the wind, the unceasing swell on this portion of the coast rolls in with the crests of the waves parallel or nearly so to the coast*," nor can it, I think, be otherwise; and the heavier the swell, the greater is the tendency to assume the direction above described. Moreover, if the proposal of the Madras Committee respecting the entrance be adopted, the north side will be still further protected from wave action.

I would therefore suggest a postponement of the raising of both sides of the harbour until further experience has been gained as to the necessity for the work. The raising may be executed at any time; it is not a work that presses; and does not form an integral portion of the reconstruction; and if it be postponed, valuable experience will be gained as to its necessity during the period of reconstruction.

I think, however, the cost of raising the sides might be retained in the estimate as a contingency to which Government may be liable.

The raising of the faces and elbows might be carried on simultaneously with reconstruction.

2nd.—The reasoning which I have applied to the raising of the sides will also hold good to a certain extent with regard to the strengthening of the sides by random blocks thrown down on the sea side to form a "wave-breaker," for I am induced

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to think that it will not be necessary to adopt so large a provision as that contemplated in the report of the Home Committee.

In my previous report I suggested that the sides should be protected by throwing down additional gneiss rubble on the sea side, and I am inclined to think that this will suffice. I should at all events be disposed *at first* to lay down not more than a few hundred feet of "wave-breaker" at that portion of the side which is nearest to the "elbow," and additions may be made to this at any time should it be found necessary.

I should be disposed, therefore, as in the case of raising the sides to postpone the execution of this portion of the works, whilst retaining it in the estimates.

3rd.—The Home Committee has suggested for the reconstruction of the faces and elbows three alternative propositions, namely—

(*a*) Replacing the fallen blocks in their original position, and adding random blocks as a "wave-breaker."

(*b*) Constructing a new wall 60 feet in the rear of the original wall, and adding a "wave-breaker" of random blocks.

(*c*) Depositing random blocks on the *debris* of the original wall.

Alternative (*a*) is recommended, *if practicable*; but some doubts are thrown by the Home Committee upon the practicability of the plan. The Madras Committee also expresses strong doubts as to its practicability, which I must admit I share; and even assuming its practicability, the Madras Committee considers that it must be attended with very great difficulty and delay, and should on that account be rejected, narrowing down the selection to alternatives (*b*) and (*c*).

Alternative (*b*) is quite practicable, but the Home Committee points out that it will shorten the harbour (already very short), and that it will be undesirable to build on the unconsolidated rubble.

In addition to the objections raised by the Home Committee, I am of opinion that the *debris* of the original wall, irregular as it is, and being in advance of the new wall, would probably set up a very serious wave action of which it is impossible to predict the results. In some places the wall stands to its full height, whilst in other places there are breaches, and the only way of obviating a complicated wave action would be thoroughly to dismantle the old wall and reduce it to an even surface; and this would be a very expensive operation.

Alternative (*c*) "*possesses*" (in the opinion of the Home Committee) '*advantages, and, as regards construction, is a safe system to follow.*" It is objected to only on account of necessitating short walls at its extremities for entrance lights, and on the ground of admitting through its interstices some disturbance inside the harbour. The Madras Committee, however, points out with much force that these objections are not valid. The entrance lights are not needed, and, even if they were needed, could be arranged for otherwise; and the core formed by the old wall would prevent disturbance in the harbour through the interstices of the random blocks.

The Madras Committee then, considering that there is "no valid professional objections" to the random block system of construction, give a decided preference to alternative (*c*), and with this opinion I entirely concur.

I think, however, that the section proposed needs some slight modification. It is well known that if a wave be deflected, its force will be far less than if it be allowed to break; and waves will be broken by any slope having an inclination less than 1 to 1; whilst from that angle to the perpendicular the wave will not be broken, unless it be nearly on the point of breaking when it reaches the slope. Now the section proposed averages about an inclination of $1\frac{1}{2}$ or $1\frac{3}{4}$ to 1, and on such a surface the waves will probably break instead of being deflected. Nearly all the French breakwaters constructed on the random block system have an average slope of 1 to 1, and I recommend the adoption of that slope in the section to be given to the face and elbows of the Madras breakwater when reconstructed. The same reasoning holds good as regards the rubble deposit, which is shown on the section, at an average slope of about $3\frac{1}{2}$ to 1.

The adoption of this slope would give a tendency to convert vertical into horizontal motion, and make the waves to break heavily on the breakwater. The lower portion of the wave being restrained, the upper part would be flung heavily on the breakwater. I would suggest that *no additional rubble* should be placed on the outside of the section, but that the blocks should be allowed to fill up any deficiencies in the section; this would not entail any larger expenditure of blocks than is at present contemplated, if the French practice of slopes of 1 to 1 be followed; and the section would be safer from disturbance.

I think that the fact that the rubble has been displaced by the wave action shows the necessity for extending the casing of large blocks to that depth.

I enclose typical sections (diagram Nos. 1 and 2) which I recommend as modifications of those which accompany the report of the Madras Committee.

4th.—The Home Committee suggests the reduction of the entrance from 550 to 450 feet in width, whilst those who have had actual experience in working vessels in and out of the harbour consider that this will render the entrance "difficult and dangerous to a degree out of all proportion to any advantage that can be gained by it"; and although from a study of the comparison with other harbours, I am inclined to think that a reduction might be made in the width of the entrance, yet, in the face of so strong an expression from those who have had actual experience, it would be prudent to defer any reduction of the entrance, as I suggested in my previous report, until further experience has been gained; and I think that if two fixed beacons were placed at each side of the entrance as proposed to be reduced by the Home Committee, the necessary experience might be practically obtained before the time arrives for carrying out the reduction proposed.

There is no doubt that even with this reduction there will be a considerable movement within the harbour.

I have calculated the probable intensity of the swell in the harbour at different distances from the entrance and with waves of different initial height outside the entrance. The following tables give the results of my calculations.

Table No. I.

WIDTH OF ENTRANCE 550 FEET.

Distance from entrance.	Height of swell in harbour when initial height of waves outside is		
	25 feet.	30 feet.	35 feet.
	ft.	ft.	ft.
500 feet	7·32	8·78	10·24
1,000 „	6·68	8·02	9·36
1,500 „	6·26	7·51	8·76
2,000 „	5·92	7·10	8·29
2,500 (head of jetty) ...	5·65	6·78	7·90

Table No. 2.

WIDTH OF ENTRANCE 450 FEET.

Distance from entrance.	Height of swell in harbour when initial height of waves outside is		
	25 feet.	30 feet.	35 feet.
	ft.	ft.	ft.
500 feet	6·40	7·68	8·96
1,000 „	5·79	6·94	8·10
1,500 „	5·37	6·44	7·52
2,000 „	5·04	6·05	7·06
2,500 (head of jetty) ...	4·78	5·74	6·69

These results only give the swell caused by that portion of the wave which passes through the entrance, and do not take into account the disturbing effect of any portion of the wave that may pass *over* the structure.

It will be seen then from these tables that with a 30 feet wave outside the harbour the reduction of entrance would approximately reduce the swell at the head of the jetty inside the harbour from 6·78 feet to about 5·74 feet, or in round numbers about one foot.

The "Madras Committee," however, has recommended the closing of the present entrance and opening of a new entrance in the north elbow, this entrance being covered by a projecting breakwater curving out from the eastern tangent of this elbow.

The entrance to a harbour at right angles to the general direction of the swell is generally considered to be a very disadvantageous arrangement; for when a vessel is entering such a harbour, half protected by the entrance, and half exposed to the action of a heavy wave, it is liable to be swung round, and strike the entrance before it can recover itself; this is a contingency to which modern vessels from their extreme length are especially liable.

The projecting breakwater proposed by the Madras Committee will allow some distance for a vessel to recover itself under these circumstances, but I think scarcely sufficient. Colonel Trevor, the Secretary, suggests an increase to the length of this projection, and I am of opinion it should be increased not only for covering the entrance, but also in order to allow a vessel to recover itself if struck by a wave when half protected.

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I presume that the nautical authorities on the Madras Committee have satisfied themselves as to the practicability of a ship entering the harbour by such an entrance in stormy weather; but I think it would be desirable to refer this question to the highest nautical authorities in India.

Supposing the entrance to be practicable, the change of entrance would doubtless add very greatly to the quiescence of the harbour; but I must confess that I am somewhat sceptical of the *absolute* safety of vessels in Madras Harbour during a cyclone, even under the conditions of having raised the face and elbows and closed the seaward entrance.

Assuming, however, the feasibility of such an entrance, I am of opinion that the form of breakwater proposed for covering this entrance requires some modification. In its proposed form it is open to serious objections, involving, as it does a re-entering curve which would never stand the blow of a cyclonic wave.

I have, in my previous report, adverted to the confluent action of the waves along the faces and round the elbows of this breakwater, and I annex a diagram (No. 3) showing in black arrows the action of waves on a breakwater such as that proposed by the Madras Committee.

It will be seen by this diagram that the meeting of the confluent waves along the face with those rolling in direct from the sea would set up a very severe action, and the blows on the concave surface at A would be so severe that nothing in the shape of a breakwater could withstand it.

Moreover, the action of the waves would not only be severe on the breakwater, but, as the confluent action would be diametrically opposed to the direct action of the waves rolling in at B, a very turbulent action of the waves would be set up, which would seriously affect the passage of a vessel into the entrance.

I have shown in red the modification I would propose for adoption in case an entrance at the elbow should be approved, the red arrows showing the action of the wave upon it, which would be far less intense than in the previous case. On the other hand, there is an undoubted objection to the modified form in that vessels entering and leaving the harbour would be thrown further into shoal water than in the form proposed; but if this be an insuperable objection, I am of opinion that the idea of an entrance

at the elbow must be abandoned, for a concave face in such a position is in my opinion quite inadmissible.

There is another alternative entrance that might be worthy of consideration as offering shelter to the harbour without the objectionable features of either of the foregoing alternatives. This is shown in diagram No. 4 appended to this note, one of the faces being extended so as to cover the existing entrance, and, by demolishing part of the other face, a sufficient width for a free entrance may be obtained.

This would allow an entrance in deep water, and it is doubtful whether it would be more expensive than the plan proposed by the Madras Committee, for the portion E F would be equivalent to filling in the present entrance. The portion F G in diagram No. 4 would be equivalent to the portion D C in diagram No. 3; and the portion H K to be demolished would be somewhat shorter than the portion of the elbow which it is proposed to demolish for a new entrance. On the other hand, the portion F G in diagram No. 4 will be in deeper water than the equivalent portion D C in diagram No. 3.

It may be convenient to sum up my opinions on the four suggestions of the Home Committee as follows:—

1st.—I recommend that the raising of the faces and elbows of the harbour be accepted, but that the raising of the sides be postponed pending further experience.

2nd.—I recommend that the wave breaker for the sides be only carried out at first for two or three hundred feet from the elbows, and that its completion be also postponed until the necessity for it can be determined.

3rd.—I recommend the adoption of the random block system on the *debris* of the original wall, but I advise that the sections be modified in accordance with the typical sections given in diagrams 1 and 2 appended to this note.

4th.—I recommend a postponement of the reduction of the width of entrance until it can be ascertained by practical experiment with fixed beacons that such a reduction can be allowed with safety to the shipping; and with regard to the alternative entrance from one side, I advise that the question be referred to some eminent nautical authority in India, bearing in mind that a concave face to the breakwater is quite inadmissible.

If there should be a tendency to rapid shoaling to the south, it might be desirable to extend the other face so as to give the entrance to the north instead of to the south; but in this case the extension would have to be rather longer to give an equal cover to the entrance.

3-8-83. G. L. M.

The settlement of the 3rd point, namely, the method of reconstructing the face and elbows, is the only one that presses for an immediate decision, and it is very desirable to arrive at a decision on this point with the least possible delay, not only to enable the manufacture of blocks to be recommenced, but also to prevent further disaster to the existing works from future cyclones by protecting them with random blocks.

17-7-83. G. L. M.

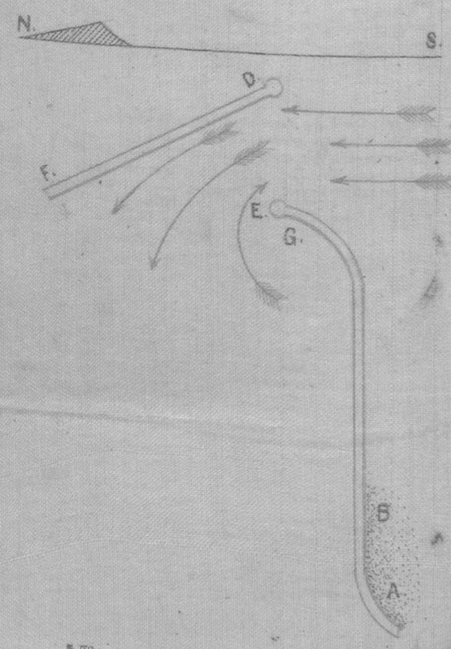
I have discussed these proposals with Mr. Molesworth personally, and concur in all his proposals. Subject to correction by nautical and local authorities, I think the entrance recommended and illustrated in diagram No. 4 the best yet suggested.

19-7-83. W. S. T.

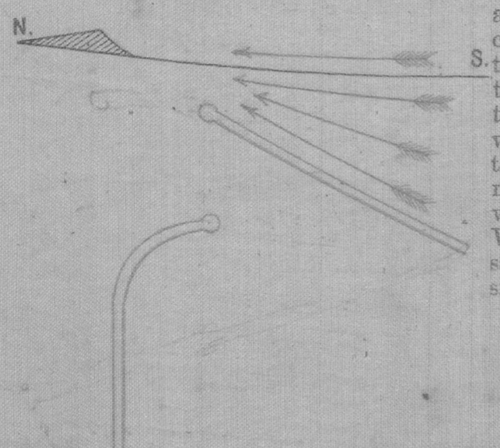
Colonel Brownlow.

I detained this case, as explained verbally to Secretary and Mr. Molesworth, in order to obtain information regarding the strength, duration, and effect of the littoral currents. In respect to these see what Captain Taylor says in his letter of July 26th accompanying. Having regard to the greater duration and strength of the northerly current, and especially to what is stated regarding the great quantities of sand carried up from south to north by it, I most unhesitatingly advocate turning the mouth of the harbour to the north instead of the south. A current of 2 miles an hour moves 3 feet in a second, just the velocity of the Ganges canal in its upper reaches, and I am very confident that, with a northerly current of that strength, a very awkward eddy would be generated at E* of sketch in the margin, if the harbour mouth is made to face the south.

This will be very much increased if the current should ever increase to 3 miles an hour, or 4½ feet a second, as it may easily do when the south-west monsoon is blowing strongly, and the danger to ships moving in and out would then be considerable. They could not hug the projecting face F D, as the current would be setting strongly on to it, and thus would be extremely likely to come to grief at E, as the steering would be very uncertain. Besides when the sand, now being deposited at A B, moves up to the end of the projecting wall, a bar is sure to be formed at E. With the mouth opening to the north the sand would simply travel along the outer-side of the projecting face, and would be



* The current setting into the harbour along inner face of F D will tend to heap up the water within the enclosure and generate a current setting *out* at E G.



constantly removed by the same action as that which now tends to cause erosion of the beach to the north of any projection from the beach.

2-8-83. H. A. B.

The currents on the Madras coast are sustained by the Monsoon winds and prevailing local winds.

2. Thus in the latter half of March when the local long shore winds blow, the current sets to the northward steadily, and at a rate varying from ½ to 1½ or sometimes 2, according to the strength of the wind close inshore and as far out to sea as the observation of coasting vessels reach. This wind continues to blow in April and May when it becomes merged in the south-west Monsoon wind which lasts till September. There is, therefore, a period annually of six and a half months during which a current runs to the northward. In October there is little or no current, but on the arrival of the north-east Monsoon in November a current from the north sets in and continues through December and January at about the same rate as the south-west Monsoon current, ½ to 1½, or in extreme cases 2 miles per hour. February and part of March no current to be detected. The current from the north thus obtains for little more than three months as opposed to six and half from opposite direction. The effect, therefore, is found to be that the sand with which the surf and sea near the shore is charged travels in great quantities from south to north and is arrested by any projection from the shore and at once deposited while the clear water passing round the obstruction upon coming again into contact with the beach naturally takes up whatever sand it can find and thus causes erosion. Some partial restoration of this action goes on during the north-east Monsoon but the ultimate proportionate effect is as described. Examples of this are to be found at Covelong where there is a rocky spit, at the wreck of the *Southern Monarch* at Chepaok; the Madras Harbour Works, and at Pulicat and Armeghon. In the case of the Harbour the action has already led to very great expense in protecting the north beach now as there is no considerable rise and fall of tide to expose any mischief that is going on and no daily equal ebb and flow which might repair such mischief, and the current being very searching and the sand easily moved, it follows in my opinion that there will always be danger to any work of the nature

of an upright wall the value of which depends upon maintaining its equilibrium whereas at Madras sand is the first and chief element of foundation. We have in fact one unequal tide throughout the year instead of two equal ones daily as in England and elsewhere.

26-7-83. J. H. T.

I quite agree with Colonel Brownlow as to the desirability in this case of turning the opening to the north instead of the south, but I am of opinion that the northern entrance will require rather greater prolongation than that which has been shown for an opening for the entrance to the south.

3-8-83. G. L. M.

It might perhaps be as well to add, to my original note, the remark which I have marked in red. (See marginal note facing diagram No. 4).

3-8-83. G. L. M.

I do not think the current can possibly carry sand in any sensible quantities beyond the range of the surf. In 8 fathoms of water it would require very heavy seas indeed to stir up the sand at the bottom, and without such stirring up there would be no sand in suspension for the current to carry. Inshore, *i.e.*, within the range of the surf, I have no doubt that the waves and current combined cause a considerable movement of sand, and by degrees the foreshore will probably be advanced seawards by this process, and may in time get to the head of the harbour itself. But this must be a slow advance at best.

However, it would be prudent to make the opening on whichever side is least liable to be encroached upon, and if this be the north, the entrance should be at the north-east angle. We may send Mr. Molesworth's note to the Secretary of State.

3-8-83. W. S. T.

Hon'ble Member.

I think that before reporting to the Secretary of State, it would be only fair to send the notes to Madras for any remarks the Committee wish to offer. To close the front entrance seems the only way to make the harbour even moderately useful, but it will be a nasty place to take a ship into from either side. At the same

time, I would sooner take a ship in from the north (considering that she would be ordinarily head to the prevailing winds) than from the south.

9-8-83.

T. C. H.

Civil Works Branch.

10-8-83.

W. S. T.

G. C. B. Press, Simla.—No. 176 P. W. D.—3-9-83.—52.

Pier & Jetty.

Rendered

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Report of the Committee appointed in G.O., No. 1259 W., dated 30th April 1883 and re-assembled under instructions conveyed in G.O., No. 2662 W., dated 22nd September 1883.

The Committee re-assembled under G.O., No. 2662 W., dated 22nd September 1883, to consider the notes received from the Government of India on their former report, have the honor to submit the following remarks.

2. The recommendations made by Mr. Molesworth are summarised as follows :—

"*First.*—I recommend that the raising of the faces and elbows of the harbour be accepted, but that the raising of the sides be postponed pending further experience.

"*Second.*—I recommend that the wave breaker for the sides be only carried out at first for two or three hundred feet from the elbows, and that its completion be also postponed until the necessity for it can be determined.

"*Third.*—I recommend the adoption of the random block system on the débris of the original wall, but I advise that the sections be modified in accordance with the typical sections given in diagrams 1 and 2 appended to this note.

"*Fourth.*—I recommend a postponement of the reduction of the width of entrance until it can be ascertained by practical experiment with fixed beacons that such a reduction can be allowed with safety to the shipping; and with regard to the alternative entrance from one side, I advise that the question be referred to some eminent nautical authority in India, bearing in mind that a concave face to the breakwater is quite inadmissible."

And an alternative proposal for covering the entrance to the harbour was made, which subsequently Mr. Molesworth amended in accordance with a suggestion by Colonel Brownlow.

3. Considering these recommendations in order, the Committee would only remark with reference to (1) that it appears to them no disadvantage that the sides of the harbour should be kept low, as the tops of the waves which would spill over into the harbour would be clear water which would mix with the otherwise stagnant water within the harbour and cause an outward flow to sea through the entrance.

4. With regard to (2) the Committee are satisfied that the wave breaker is necessary to the whole of the north side. The circumstances of the north and south side are very dissimilar, while the latter is comparatively sheltered during storms and is causing an accumulation of sand on the sea side, the former is exposed to the first effort of the storm in the north-east monsoon and is not protected by any outside bank. The necessity for some further outside protection is now apparent for, although since the storm of November 1881, some 5,000 tons of large gneiss rubble have been tipped as foreshore, yet the centre joint continues to open although the work has not been heavily attacked since the above date. Bearing this in mind the Committee would recommend the construction of the wave breaker on the north side as one of the first things to be done.

5. In the despatch of the Secretary of State which was communicated to the Committee with G.O., No. 1259 W., dated 30th April 1883, it was stated that the views of the Home Committee should be accepted as closing the discussion on the principle of restoration to be followed, the Committee therefore framed their estimates according to the sections which were designed by the Home Committee. They would only remark with reference to (3) that experience has shown that the rubble base will not stand at a slope of 1 to 1.

6. As regards recommendation No. 4 the Committee feel very strongly that the northern entrance suggested by them is the only satisfactory arrangement. Attached to this report is a letter from the Master Attendant forwarding the opinions of some

of the commanders of the large steamers using the port, the best nautical opinions that can be obtained. It will be seen that all agree in considering the present entrance should be closed and that the northern entrance proposed would be the best that could be designed.

7. It appears to the Committee that there can be no question regarding an entrance on the sea face with a protecting arm to the south. Colonel Brownlow has adduced arguments against it which have been accepted by Mr. Molesworth and which may be considered conclusive.

8. An entrance on the sea face with a protecting arm to the north is, in the opinion of the Committee, open to serious objection, and is not to be compared with the proposed entrance at the north-east corner. In the first place the sea would still during the north-east monsoon set into the harbour and create a swell which one of the principal objects of the Committee's proposals is to avoid.

Secondly.—An entrance on the sea-face would curtail the deep water space within the harbour which could be taken the fullest advantage of with a northern entrance.

Thirdly.—Such an entrance would involve the very difficult task of dismantling and removing the strongest and most deeply founded portion of the whole northern wall, whereas the entrance proposed by the Committee only entails the clearing away of that portion of the work that is already shaken to its very foundation, and is now the most ruined part of the whole structure.

9. As regards the form of the protecting arm or horn the Committee would observe that the slightly curved form proposed by them was adopted after due consideration, as will be seen by reference to their first report, and while allowing the objection raised by Mr. Molesworth to any re-entering angle on the face of the work, they consider that the arm might be made sufficiently strong to resist any action that may be expected. It would in fact be possible by increasing the block protection on the concave side of the curve, to make the outward face an almost direct continuation of the face wall at no very serious additional cost.

10. The proposed shape of the protecting arm to the northern entrance given by Mr. Molesworth would tend to force ships entering and leaving harbour into shoal water, and any such tendency is to be avoided, though during the north-east monsoon when there might be some difficulty in entering, it is to be noticed that the effect of the northern arm is to create an outward set from the shore to the extremity of the harbour which would make the lee shore less to be feared than it proverbially is.

11. The Committee are, however, willing to leave the question of the direction and shape of the projecting arm for future consideration and would not object to some modification of the curve they have proposed. The construction of this arm will be the last part of the work to be done; the eastern entrance will have been closed and the northern entrance opened before it will be proceeded with, and the final settlement of the question may therefore, if desired, be postponed. The Committee, however, consider that the more nearly the entrance can be made to approximate to that proposed by them the more satisfactory it will be found to ships using the harbour.

(Signed) J. O. HASTED, Col., R.E.
(,,) J. H. TAYLOR, Lieut., R.N.R.
(,,) T. E. MARSHALL.
(,,) F. N. THOROWGOOD, M. Inst., C.E.
(,,) N. St. B. BEARDMORE.
(,,) C. BOWEN, Major, R.E.,
Secretary.

Enclosures.

From J. H. TAYLOR, Esq., Lieutenant, R.N.R., Master Attendant, Administrative Department, Madras, to the Acting Chief Secretary to Government, dated 4th September 1883, No. 8807.

I have the honor to forward, as desired, the opinions of nautical men upon the proposed closing of the east entrance of the harbour, and opening one to the north. The opinions are all

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

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

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

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

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

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

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

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

From W. A. BURKITT, Esq., Master, S.S. *Dacca*, to the Master Attendant, Madras, dated 10th August 1883.

I have looked over the plan for reconstructing the Madras harbour, and think it an excellent idea closing up the present entrance, and having the new one at the north-east corner, and when the wall of the breakwater is built higher, we ought to have perfectly smooth water. The harbour ought also to be able to give accommodation to several more steamers, and I do not see why it should not be able to give protection to ships in case of a cyclone.—in fact, the present plan is the first which has caused me to believe in the utility of a Madras harbour.

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

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

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

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

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

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

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

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

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

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

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

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

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

Smooth water inside the harbour.

Increased moving space.

Less liability to accident to vessels entering or leaving the harbour.

Probably less difficulty to vessels putting to sea in bad weather.

Append. 25/4

286/4

286/4

Myr dear Thompson,

Ct: Hastie has asked me to show you his rough draft of Committee's report in view to your suggesting any alteration or addition to his para 4 which would strengthen it or make clearer the Committee's decision to stick to the present works for Northern side.

He is not aware when the weakness of the northern arm became more apparent. I do not know when the estimate or direction you allude to is supposed to have first existed itself, but I understand that weakness on this side was becoming more & more apparent every day & therefore of course meant for more protection works.

Any suggestions you would kindly offer to modify this part of report in above sense please let me have.

Yrs sincerely

C Chevers.

2861/29

Report of Committee appointed in G.O No 1259 M. dated 30th April 1883. & assembled under instructions conveyed in G.O. No 2662 dated

The Committee assembled under G.O No 2861 dated to consider the notes bearing on the 1st of June from Lieut Colonel Holes submit the following remarks

2. The suggestions made by Lieut Colonel Holes will be summarized as follows.

(Here enter four pages of note)

and an alternative proposal for having the extra duties performed by Lieut Colonel Holes will be recorded in accordance with a suggestion by Col. Bonnelle.

3. Considering these recommendations in order the Committee would only comment with reference to (1) that it appears to them no disadvantage that the Sides of the Harbour should be kept low, as the tops of the waves which would spill over into the Harbour would be clear water which would help to wash the obnoxious sediment out of the Harbour & cannot do more than keep the Harbour tidy.

4. With regard to (2) the Committee are satisfied that the weir breaker is necessary to the whole of the Harbour Sides; they consider that circumstances of the Harbour Sides are very dissimilar, while the latter is composed of Material from dying slums & is covered an accumulation of sand as the Sea Side, the former is Exposed to the first effect of the N.E. monsoon and is not protected by any outside bank, the necessity for some obstacle is apparent and the Committee recommend the construction of the weir breaker, as one of the first things to be done.

5. In the Report of the Ld. of State which was communicated to the Committee with H.E. No 1259 dt. 30th April 1863. it was stated that the views of the Home Committee should be accepted as during the discussion on the principle of better plan to be followed, the Committee therefore framed their Estimate according to the Letter which had been despatched by the Home Committee. They would only recommend with reference to (3) that Experiments be shewn that the rubble base will not stand at a slope of (5)

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* Please note that I insert the word further, because as the Parties interesting there has already been a great deal done to the North Pier, with gratuitous view to clamps.
JM.

6. As regards Section under the No 4. the Committee feel they ought that the Northern Entrance suggested by them is the only satisfactory arrangement. Amongst other report is a letter from the Master Attendant & Foundry. The opinions of some of the Commanders of the large Steamers being the Port, the best nautical opinions that can be obtained. While he sees that the opening in Granting the present entrance closed be closed & that the Northern Entrance proposed should be adopted, the best that cannot be designed.

7. It appears to the Committee that there can be no question regarding an Entrance of the Sea from into a Basin being the South. Col Brooks has offered arguments against it which have been supplied by Mr Rendel which may be considered conclusive.

8. An Entrance as proposed into a Basin is, in the opinion of the Committee, open to many objections, and is not to be compared with the proposed Entrance on the North. In the first place the Sea would also drift the Mouth across the Harbour & would be liable to fill up. Secondly, an Entrance as the Sea from would contain the deep water space within the Harbour which would be of the greatest advantage of with a Northern Entrance. Thirdly, it would be very difficult to dispose the dredged part of the Harbour from the Entrance while the part which is proposed by the Committee to remove from the Northern Entrance is now Mr Rendel's opinion & would be disposed without difficulty.

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9. Has expended the power of the projecting arm or how the Committee would observe that the Elasticity caused from Expansion by them was adopted, after due consideration, as will be seen by reference to their first report, and while adopting the objection raised by Mr Holesworth to any be making angles at the ends of the work, they consider that the arm might be made sufficiently strong without any additional, which may be expected, it would in fact be possible by increasing the block protection on the concave side of the curve to resist the actual force as almost direct contraction of the iron work.

10. The Mean proposed elipse of the projecting arm given by Mr Holesworth would limit to four ships entering & leaving harbour into short water & any such limiting in the accidental length during the N.E. monsoon when only there

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might be some difficulty in entering, it is the intent that the effect of the northern arm is diverted an additional set from the shore by the [illegible] of the harbour which would make the less shore less the feared than it presently is.

1/ The Committee are however willing should the question of the direction & shape of the projecting arm in future consideration and would not object to some modification of the one they have proposed. The construction of this arm will be the last part of the work done; the first entrance will have been closed & the northern entrance opened before it will be proceeded with, and the final settlement of the question may therefore if desired be postponed, the Committee however consider that the [illegible] entrance can be made as safe & suitable to vessels as proposed by them while the more [illegible] protecting

it will be found to agree
with the Estimate.

Chesapeake
28th Sept.

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Gentlemen,

I circulate for your consideration draft Report of Harbour Construction Committee prepared by Lt. Hasted.

Kindly sign the same — as in the case of our original Report — if you approve thereof.

Yours faithfully
C. Unwin

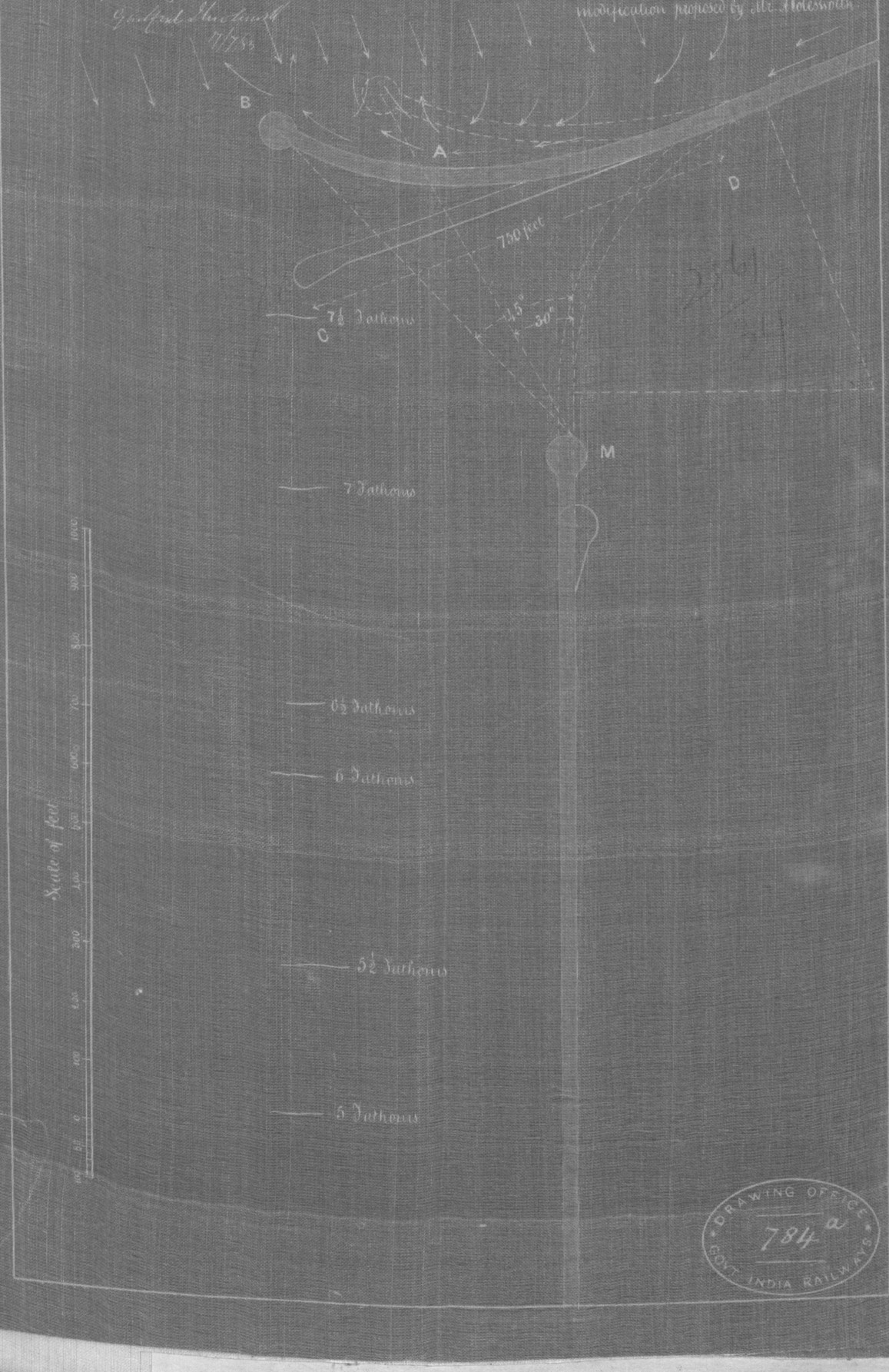
Capt. Taylor R.N.K.
Capt. Marshall —
F.N. Thornycroft Esq.
N. St. K. Headman Esq.

DIAGRAM No 3.

MADRAS HARBOUR.

Diagram No. 3 to accompany note by Mr. Molesworth dated July 17th 1853.
Diagram illustrating action of waves on the breakwater proposed by Madras Committee.

Note. The dotted lines shew the breakwater as proposed by the Madras Committee. The portions coloured black shew the increased length suggested by Col. Pierce. The portions coloured red shew the modification proposed by Mr. Molesworth



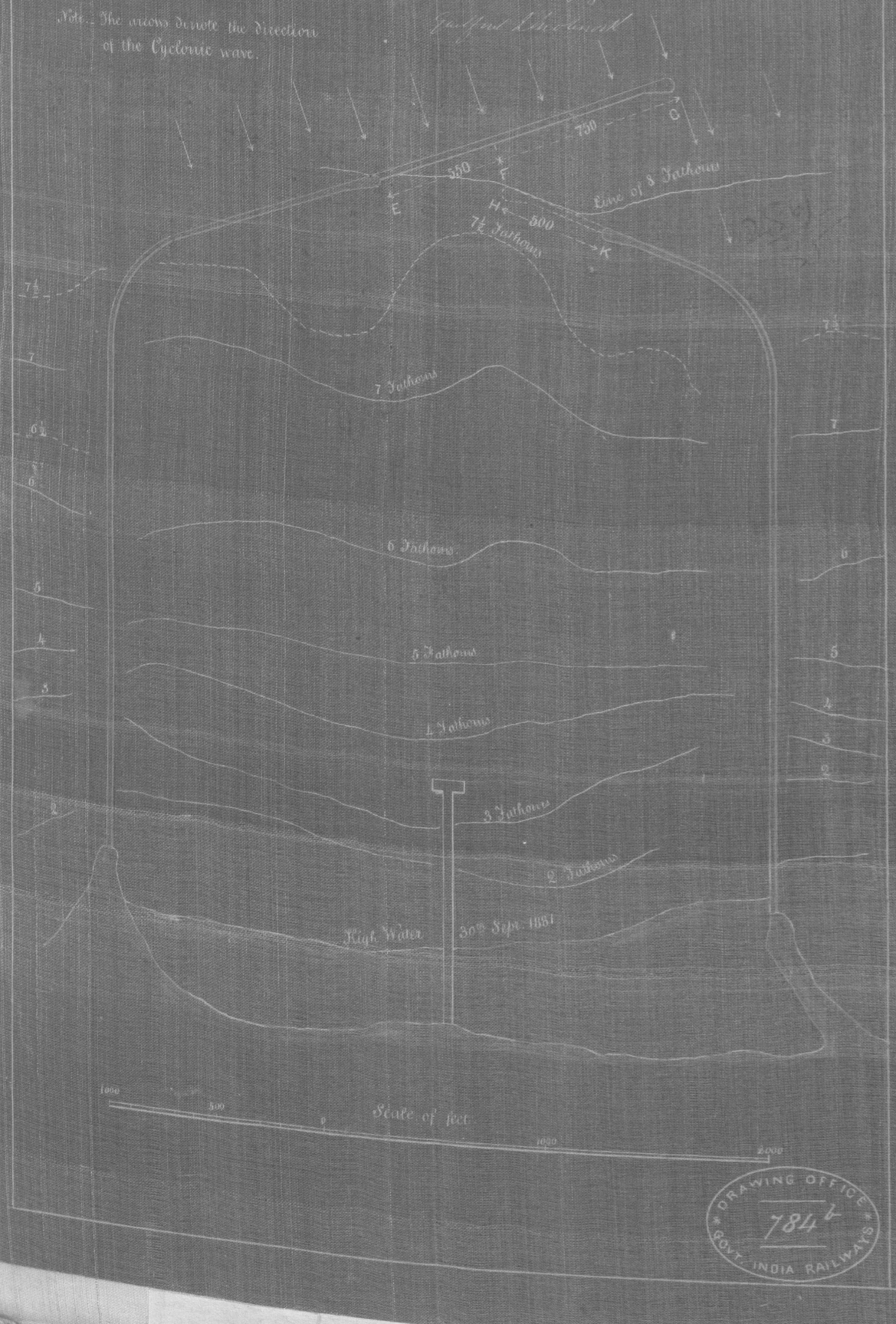
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MADRAS HARBOUR.

DIAGRAM No. 4

Alternative proposal for placing the entrance to the Harbour
To accompany Mr. Holeswoths note dated July 17th 1883.

Note.- The arrows denote the direction of the Cyclonic wave.



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NORTH PIER.

MADRAS HARBOUR

DIAGRAM No 1

Typical Sections proposed by Mr. Molesworth for the reconstruction of the faces and shoulders of the breakwater: to accompany the note by Mr. Molesworth dated 17th July 1883.

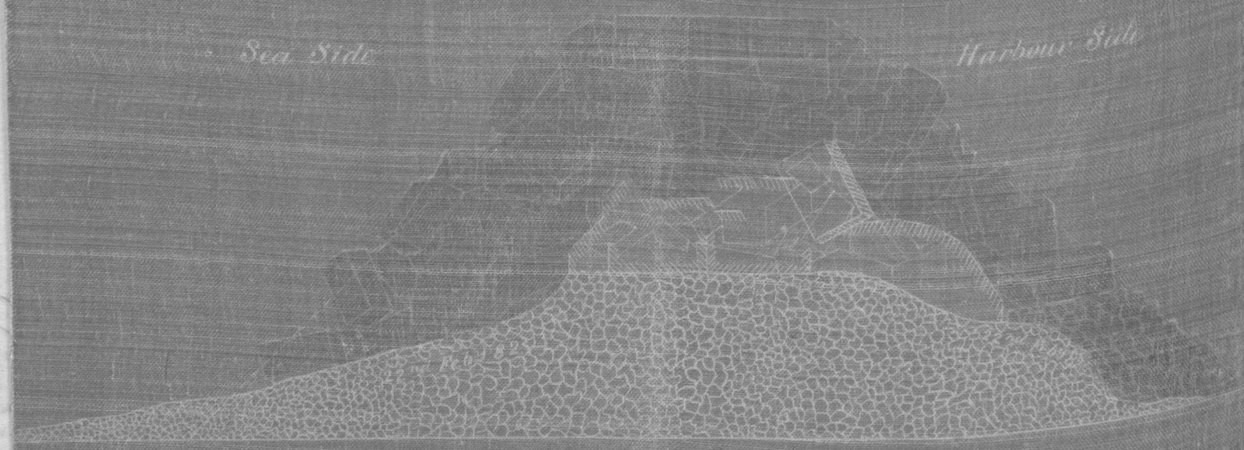
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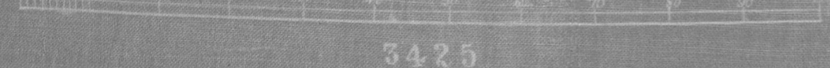
SOUTH PIER

MADRAS HARBOUR

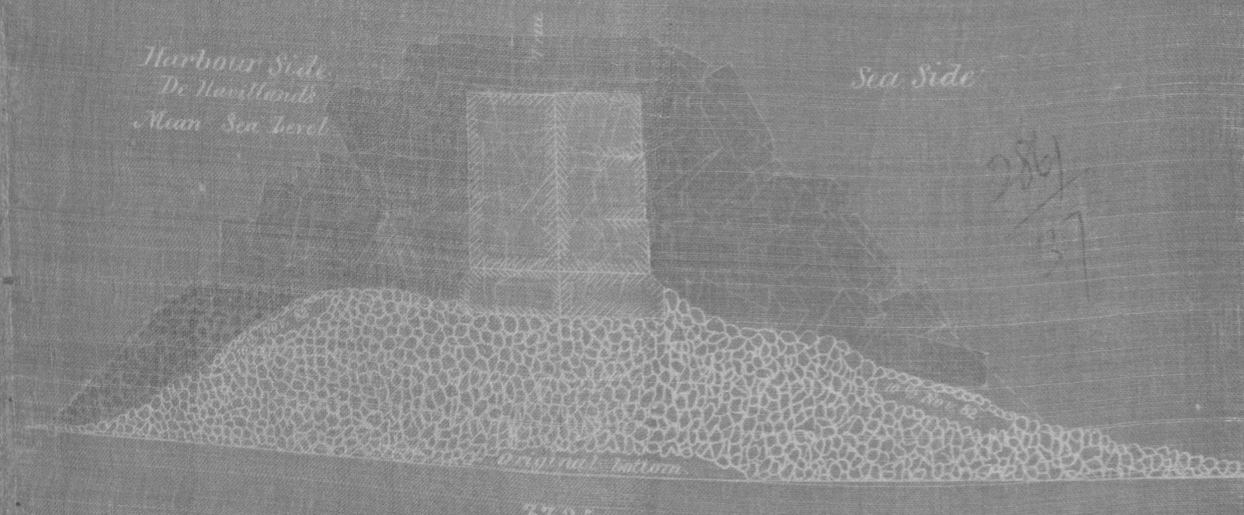
DIAGRAM No 2

Typical Sections proposed by Mr. Molesworth for the reconstruction of the faces and shoulders of the breakwater: to accompany the note by Mr. Molesworth dated 17th July 1883.

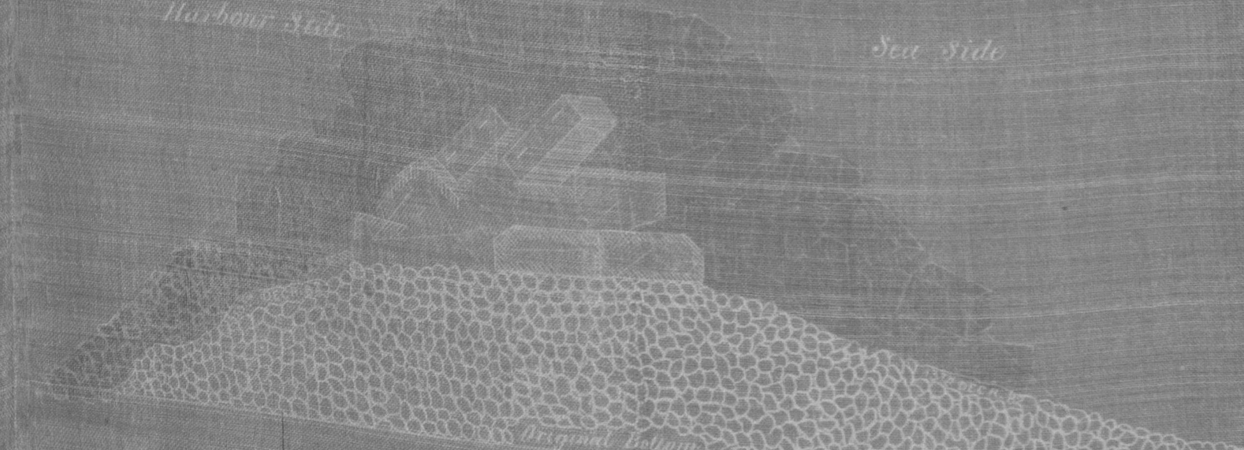
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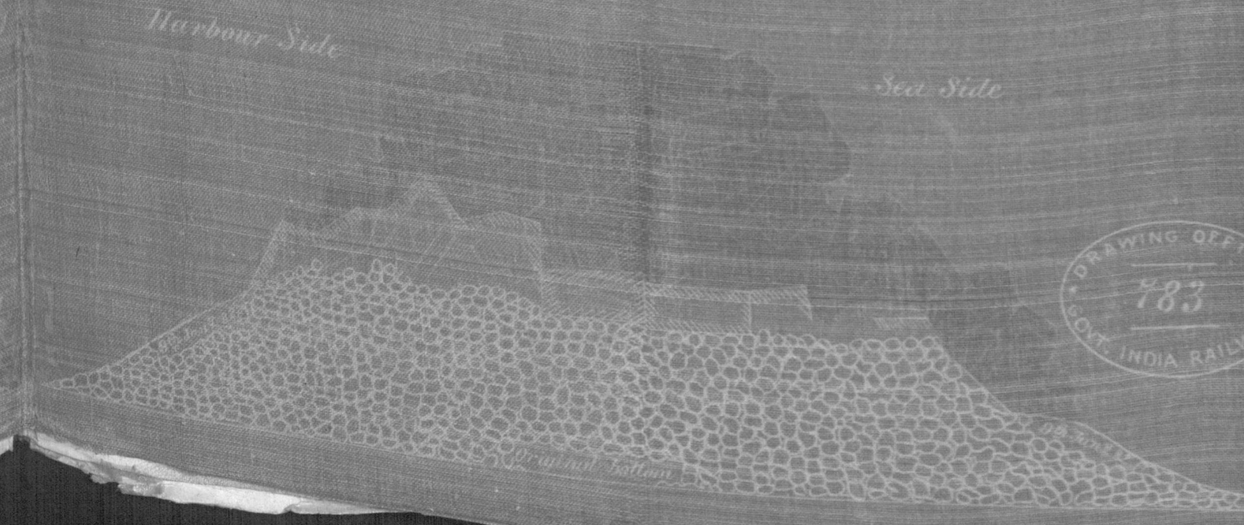
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No. 2861/W Public Works Department.

PROCEEDINGS OF THE MADRAS GOVERNMENT.

Under date the 11th October 1883

Read again the following

Papers recorded with G.O. 2662 W, dated 22nd September 1883.

Report of the Committee dated 1883.

2861/38

Ordered that the report of the Harbour Construction Committee, and the opinions of nautical men by which it is accompanied, be transmitted to the Government of India.

(M.E. No. 2862 W, dated 11th October 83)

To

The Secretary to the
Govt. of India, P.W.D.

Sir,

I am directed to acknowledge the receipt of your letter No. 341. M dated 6th September 83, forwarding

Supt. Gn. N. Works.
Marine Dept.

for the remarks of the Madras Harbour Construction Committee, notes drawn up by officers of the Public Works Department of the Government of India. In reply I am to forward the accompanying report of the Committee on the points referred for their remarks, together with the opinions of nautical men, acquainted with the conditions of the port, as to the proposed closing of the East Entrance in favor of a Northern opening.

2. His Excellency the Governor in Council trusts that, with the additional information now collected, there will be no further delay in arriving at a speedy decision as to the prosecution of the work.

P.W.
14.10.89.

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Despatch to Govt of Madras dated 29/10

A 2851 w 9.12.80
" 60 w 11.1.81
" 2854 w 15.11.81
" 2927 w 23.11.81
" 2954 w 25.11.81
" 3169 w 21.12.81
" 424 w 16.2.82
" 780-1-w 23.3.82
" 1008-9 w 24.4.82
" 1694-5 w 6.7.82
" 1912 w 28.7.82
" 1989 w 5.8.82
" 1259 w 30.4.83
B. 1370 w 2.6.82
A 1855 w 4.7.83
A 2662 w 22.9.83

Canada 8.10.05

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Govt. of 1883 Madras

PUBLIC WORKS.

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Dated

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G. O. 11 October 1883. No.

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