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TAMIL NADU ARCHIVES

GOVERNMENT OF TAMIL NADU

Public Works DEPARTMENT

G.O. No. / B.P. No:	398 — W	Press. / Mis.
Dated	13 — 2 — 1886	188 .

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GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

Buildings and Roads.
Civil Works.

READ—the following letter from F. N. THOROWGOOD, Esq., M. INST. C.E., Superintendent, Madras Harbour Works, to the Secretary to Government, Public Works Department, dated Madras, 3rd February 1886, No. 51 W.:—

I have the honor to submit a report of progress on these works during the past month of January, and I must express my regret that, although no exertion has been spared on the part of the Harbour Works staff, the end of the month arrived before all operations were in activity. I can safely say, however, at this date that all preliminaries will be completed this week, and the depositing of blocks will be begun.

2. *North pier, superstructure.*—It was not until the 15th January that the masons and plate-layers could get to full work at removing the old rails and re-laying the new roads in cement concrete, as described in paragraph 2 of my last report. By keeping the men at work overtime, so soon as the sea became smooth, the new lines of rail were completed by the 29th January; the work done being 1883 lineal feet of permanent road for the cranes, 1,938 broad-gauge railway, and 1,702 feet of narrow-gauge railway, all this securely bedded into the concrete blocks with Portland cement. A temporary line was also laid down to the extreme end of the standing portion of the pier, 2,250 feet from commencement, from which heavy boulders were thrown into the sea to form the hearting or core of the "wave-breaker." This piece of work at the end of the existing pier has taken four days longer to complete than I anticipated, and hence it comes that the Titan crane had not up to January 31st been able to get to work.

3. *North pier, foreshore and base.*—The fine working weather set in about 15th January, and since then the boats have been depositing rubble base and the divers have been busy blowing up concrete blocks which lie in the line of foundation. A total of 2,765 tons of material was deposited during January, of which 1,539 tons represent pieces of demolished blocks, 57 in number. The blocks were as usual broken up with dynamite, fired by electricity. There were 2,992 tons of very large boulders thrown over the side of the pier to form the hearting of the wave-breaker, and these boulders will now be covered with 30-ton blocks deposited by the Titan crane, preparatory to setting the abutment of the new superstructure.

4. *South pier works.*—At the south pier, all force had to be put on to re-laying the railway lines, as in December. There are now 1,657 feet of crane roads built in, and 1,747 feet of both broad and narrow gauge road. On the 18th January the south pier Titan crane, having been thoroughly tested, was advanced forward on to the south pier very satisfactorily, a distance of about 1,300 feet. I hope to get this crane to work this month, but much will depend upon the rapidity with which we can form the protecting wave-breaker at the present end of the north pier, as part of the gearing for disengaging the 30-ton blocks can only be used on one crane at a time. The inconvenience of this will only be felt at first.

5. At the rubble base of the south pier the divers have been blowing up a few concrete blocks to the extent of 185 tons.

6. *Pallávaram quarries.*—From Pallávaram quarries the outturn was small during January, as the lines of both piers were impassable during the alterations, and consequently very little rubble stone was required. Only 5,908 tons were received.

The quarry lines at Pallávaram were thoroughly inspected on 13th January by the Locomotive Superintendent and District Traffic Superintendent of the South Indian Railway in company with Mr. A. L. Pogson and myself. More siding accommodation is required there, and is now being provided, for which purpose I have had to detail several plate-layers from the Harbour Works. At the date of writing, the trains have resumed running to the number of four daily, and with the new siding accommodation this will be increased to six.

7. *Cranes and plant.*—As already reported, the south pier Titan has been completed, tested, and travelled out. The large and special crane for the wave-breakers was completed on the 29th January, and from that date I have been putting it through a series of tests for balance. Its stability appears to be precisely as shown by calculation. There were and are still some disagreeable hitches in the working of this machine, which have taken up much of the time of the leading members of this staff as well as of myself, but I hope that we shall be able to get all into smooth working order in a day or two.

8. *Less work done than was hoped for.*—Although I am much disappointed at what I have to report for January, yet I must ask that it be borne in mind that only from the 15th was the weather really good, and that the tedious and heavy work of altering all the lines on both piers practically put a stop to other work. These lines are now complete.

9. *Survey of base.*—Another piece of work that has been completed in January, and without which we could do nothing, is the survey of the whole of the rubble bases of the new work by Mr. Pogson, and this could not be attempted until the 18th January. We now are in a position to proceed freely, as I fully hoped we should have been ten days ago.

ORDER—dated 13th February 1886, No. 398 W., Public Works.

The Government fully recognise the difficulties which have been encountered, and they trust that the record for February will show better progress.

(True Extract.)

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

To the Superintendent, Madras Harbour Works.
" Consulting Engineer for Railways.
" Marine Department.

Exd. E. Fernandez.
Spare Copies

BUILDINGS AND ROADS.
CIVIL WORKS.

Govt. of {1886} Madras.

PUBLIC WORKS.

Dated February, 13*th*.

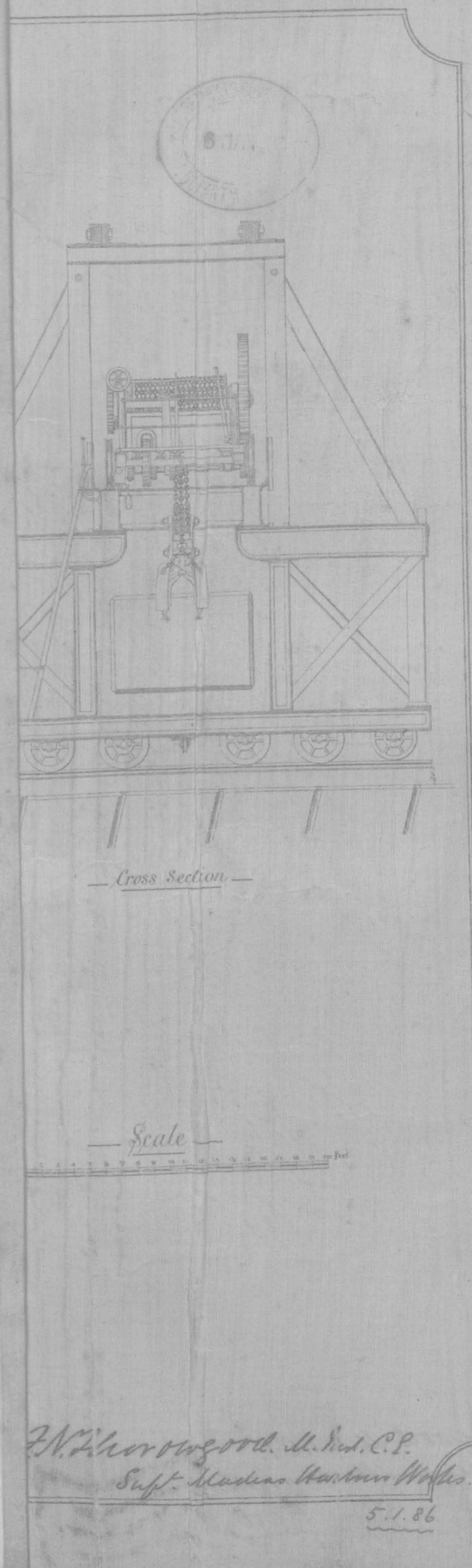
Read. *Encl.*

G.O. 13th Feb. 1886, No. 398 W.

FEBRUARY.

Madras Harbour Works

Orders on progress report, submitted by the Superintendent, of the — for January 1886.



— Cross Section —

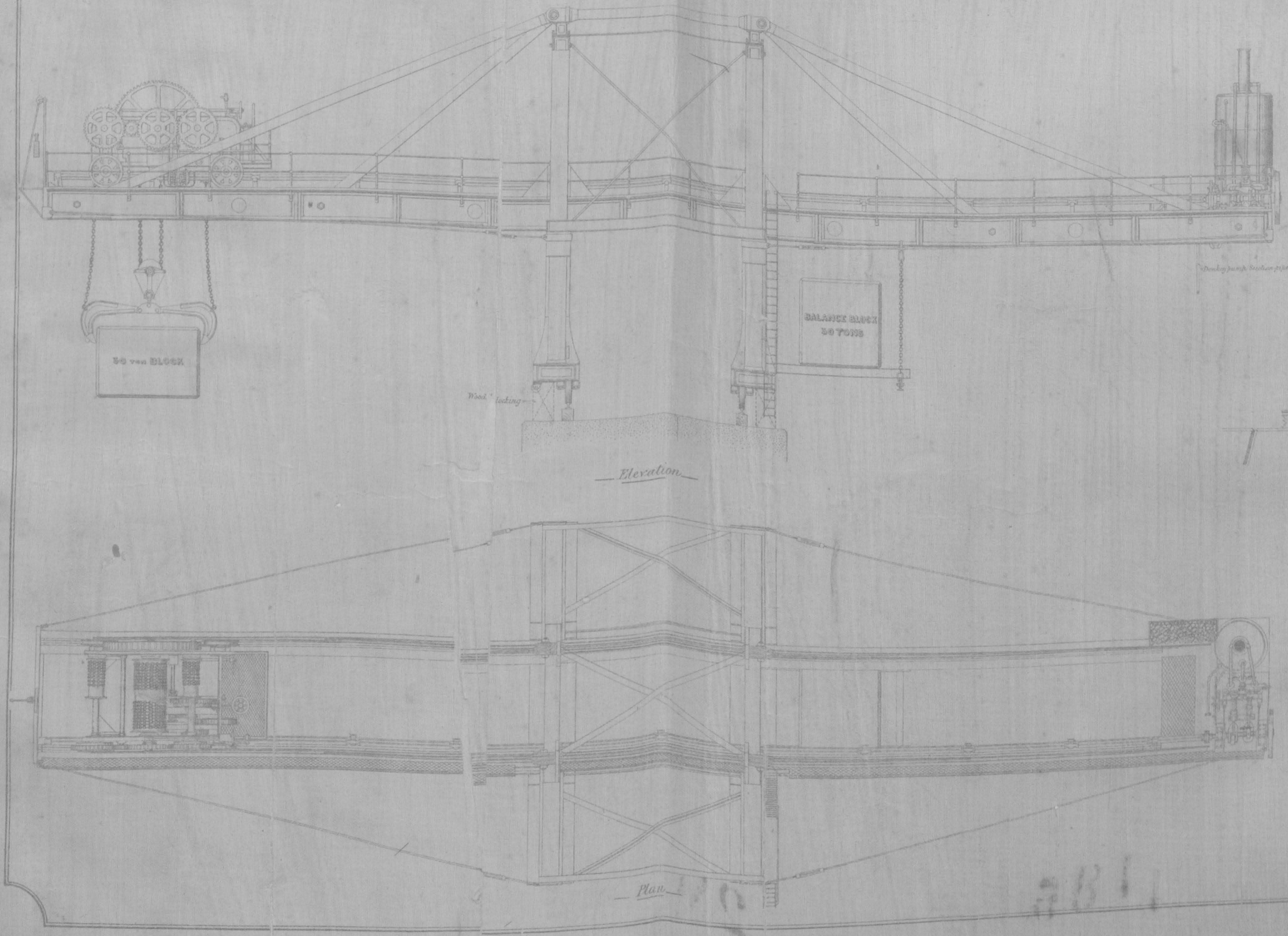
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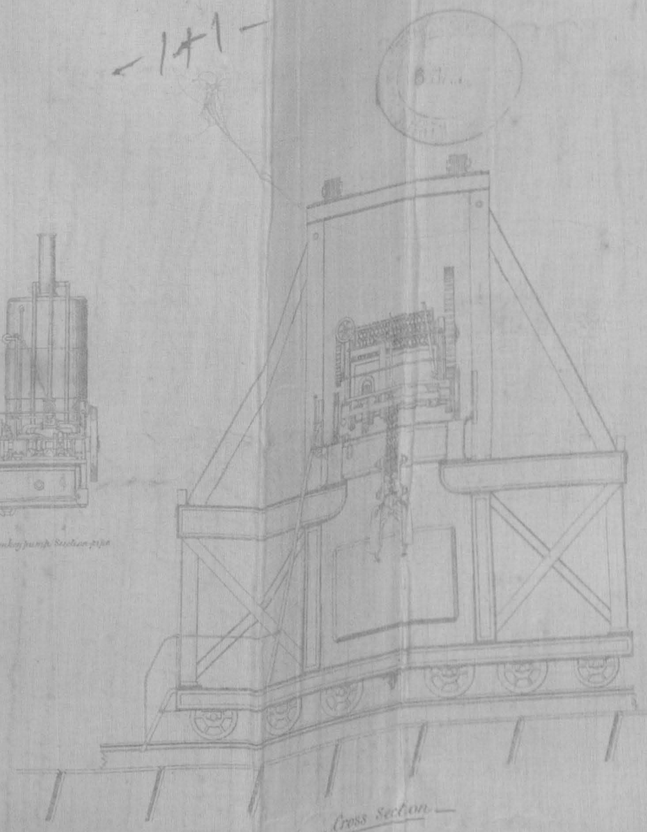
F. N. Thorowgood. M. Inst. C.E.
Supt. Madras Harbour Works.
5.1.86

3

MADRAS HARBOUR WORKS.

—Wave-breaker Crane—





Scale

J. W. Horwood. M. Inst. C.E.
Supt. Madras Harbour Works.
5.1.86

GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

Buildings and Roads.
Civil Works.

READ—the following papers :—

Despatch from the Right Honorable the Secretary of State for India, to His Excellency the Most Honorable the Governor-General of India in Council, dated India Office, London, 25th September 1884, No. 56, Public Works.

Your Excellency's Public Works letter, No. 32, dated 4th July 1884, on the subject of the Madras Harbour works, has received my consideration in Council.

2. Your Excellency forwards a communication addressed to you by the Government of Madras, together with a letter from the Chairman of the Madras Chamber of Commerce, reiterating objections to certain features in the plan of restoration of the harbour works as settled by the committee, to whom the matter had been specially referred in this country, and you state that you concur generally in the views held by the Madras Government.

3. It is recognized by every one that the chief objects which have to be kept in view in carrying out the works of restoration are (1) the structural stability of the pier walls, (2) the selection of the best position for the entrance, in view to providing a safe and easy ingress and egress for ships, and (3) the security and accommodation to be given to shipping, especially local craft, by obtaining stiller water within the harbour.

4. It is to the position of the entrance to the harbour advocated by the committee, and to its supposed unfavorable effect on the stillness of the water within, that the objections taken by local opinion appear to apply, and I have anxiously considered what course I should follow in consequence of this much to be regretted divergence of judgment.

5. The engineering questions discussed in the correspondence now forwarded to me have been so recently investigated a second time by Sir John Hawkshaw's committee, the engineer members of which are regarded as among the greatest living authorities on works of the description in question, and who were in possession of and carefully considered all the views before expressed by the authorities at Madras and of your own professional advisers, to which I cannot find that any argument or statement of fact have now been added, that, without underrating the value of local knowledge and opinions, I have felt that it would be useless again to ask the committee to reconsider their recommendations.

6. It appeared to me that, after consulting the best authorities available on the subject, no choice was left to me but to accept their decision on the questions raised, the whole of which are of an eminently technical nature, and trustworthy opinions on which can only be formed upon prolonged and extensive experience such as that possessed by Sir John Hawkshaw and Sir J. Coode, and in my despatch, No. 23, of 24th April last, I informed your Excellency that this was the conclusion at which I had arrived, and I am not now able to see any sufficient reason for changing it.

7. In the accompanying report * which Mr. Parkes, in communication with Mr. Thorowgood, has made on the subject of future operations, he expresses concurrence with the conclusions of the committee. He points out that the larger vessels should have no difficulty in getting out to sea when a severe storm is threatened, and

* Dated 21st August 1884.

that of the approach of such storms timely warning can be, and in fact always has been, given, while, as regards the smaller craft, he is of opinion that the provision of floating docks or basins, which he shows might be formed on the land reclaimed on the south side of the harbour, would protect them from danger. Nor is it anticipated that, in ordinary weather, the quietude of the water within the harbour would be better secured by a change in the entrance. These suggestions are in conformity with the views expressed in the report of Sir John Hawkshaw's committee, and, if acted upon judiciously, appear to offer a means by which to accomplish the object sought without changing the position of the entrance. Mr. Thorowgood, who is in full possession of Mr. Parkes' views, and of the reasons which have led him and the committee to adhere to the eastern entrance, has already started on his return to Madras, and will be able to furnish the authorities there with any additional particulars they may require, and it is to be hoped that conflicting views may be reconciled by further discussion. Meanwhile, the plan of operations which Mr. Parkes has proposed will not preclude the further consideration of the position of the entrance of the harbour for several months at least, and possibly for another working season, and his plans should be followed generally, on the understanding that if any additional facts or arguments are adduced bearing on the question of the entrance which appear of sufficient weight to justifiy the step, a further reference to engineering authority in this country may become desirable.

Two Titan cranes.
One crane travelling wave-breaker.

8. In the meantime the machinery, noted in the margin, has been ordered and will be despatched to Madras.

9. With regard to the estimates which form the appendices to Mr. Parkes' letter, I beg that they may be examined, and that I may be duly informed whether they are such as may be accepted.

Enclosures.

P.W. 1612/84.

Madras Harbour.

23, Abingdon Street,
21st August 1884.

In the concluding paragraph of my letter to you, dated 5th July last, I stated that I was preparing a report, in which I proposed to deal with the various questions which have accumulated in the last two years, and which would include a more detailed explanation and estimate of the proposed works of restoration, together with a classified statement of the operations carried on, and the expenditure incurred, during the period of the general suspension of work. I have now the honor to submit that report.

2. I will begin with the proposed works of restoration. The general character and extent of these works will be as laid down in the first joint report of the committee, consisting of Sir John Hawkshaw, Sir John Coode, and Professor Stokes, dated 23rd January 1883, which I accept as my implied instructions. But the proposals I am about to submit are the result of a careful reconsideration of the existing state of the works, based on records of later date than those laid before the committee above mentioned, and aided by personal conference with Mr. Thorowgood. The details of the new work have been independently designed, but where my conclusions differed from those of the committee I have carefully investigated the grounds of difference, and when I thought there was reason for doing so, I have not scrupled to increase the dimensions given by the committee, and to introduce some additional precautions.

3. There are on the other hand one or two features of the committee's plan, of which I think it only right to state that I am not myself satisfied of the necessity, but I have included these in my own design and estimate in deference to the opinion of the committee. They are works for the execution of which no immediate provision can be made, and if I feel it my duty at some future time to raise the question of their being carried into execution, it will be in consequence of some definite confirmation of my present doubts.

4. On the accompanying general plan of the harbour, to a scale of 200 feet to an inch, the new works are shown in red, and on the sheet of cross sections the character of the work at the different points is shown.

5. Commencing with the shore end of the north pier, and noting that the numbers represent the distance in feet from the point B, the first cross section from 200 to 250 shows the addition required to a special weak point. It is simply the continuation of a form of protection which was applied in 1877 as far as 200, and was so far very effective. There was at that time no occasion to carry it further, but the rubble foreshore has since been worn away by the action

of the sea, and requires feeding and protection. This is shown not only by the foreshore being rather bare in front of the wall, but also by the fact of the centre joint having latterly opened a little, which indicates a settlement. It will be seen by the section that the superstructure is only two blocks high at this part, so that it is founded at a depth at which the action of the sea is considerable, and a wide sloping foreshore is the only protection. Beyond the site of this special protection the superstructure is three blocks high, and founded at a lower level. The protective work consists of a rubble bank 50 feet long and 22 feet wide at the top, and tapered off at either end for a further length of 40 feet. On the top of this rubble 16 concrete blocks, each 9 feet × 9 feet × 6 feet and weighing 30 tons, will be built during the ensuing three months, when the wind and sea may be expected to be invariably from the southward. The northerly seas of the next north-east monsoon will wash down the rubble bank, and the concrete blocks will drop and form a facing for the submerged foreshore, as was the case with similar work in 1877. As this work can be done with appliances now on the ground, as it is of importance to carry it out during the present season, and as it may fairly be considered included in the sanction already given for the protection of existing works, Mr. Beardmore has been instructed to proceed with it; 2,500 tons of rubble and 288 cubic yards of concrete blocks will be required, and the cost will be about Rs. 7,500.

6. The above work will occupy the length from 160 to 290. In the remainder of the length, from 0 to 400, all that is required is to fill up the existing foreshore with a little additional rubble as may be required. This is in accordance with section I of the committee.

7. At 400 the line of continuous protection by random blocks will commence, but from 400 to 900 it will be of gradually increasing dimensions, from a single block laid against the foot of the wall at 400 to a mound 20 feet wide at the level of high water at 900. Within this length the depth of water is such that any waves of sufficient height to be formidable will have been broken outside, and a wave-breaker, as such, is not required. All that is required is a protection against the scour of the foreshore.

8. At 900, where the depth at high water is 25 feet, and from thence outwards, the dimensions of the wave-breaker are intended to be such as to prevent the blow of the wave from falling with its maximum force on the superstructure. What these dimensions should be are not determinable, so far as I am aware, by any recognised rule, whether based on theory or experience. It is a matter in which each engineer must use his own judgment, and mine, based on the best data I am acquainted with, would give rather greater dimensions than those shown by the committee. The difference so far as cost is concerned is not very great. If the additions were made by increasing the quantity of concrete blocks, the increase of cost would be about a lakh and a half, but if made (as I think may be done without any infringement of the essential principles laid down by the committee) by forming the interior of the mound of large rubble, the increase of cost would be only half a lakh. I think I am justified in asking the Government to sanction this modification of the design, so that it may cover my own conceptions of the required conditions of stability, but I shall, of course, be prepared to submit my conclusions to further consideration if it is considered desirable to do so.

9. It will be understood then that the following dimensions for the wave-breaker are rather in excess of those shown by the committee, but the excess is obtained by forming a nucleus of large rubble against the face of the wall and covering it with blocks. This large rubble will be deposited immediately before the blocks, so that it may not be exposed to the wash of the sea before being covered with blocks.

10. At 900 feet, then, as before said, the width of wave-breaker at high water (taken as one foot above De Haviland's mean sea level) will be 20 feet, and the width will gradually increase to 28 feet at 2,200 (see sections at these points). The blocks will be allowed to form their own slope to seaward, each block being simply carried out by the wave-breaker crane to the required distance and dropped into the sea, till the mound has reached the required height. If future storms should draw the mound down to a flatter slope more blocks will have to be added to maintain the designed width at high water level. The slope of 1½ to 1 shown on the sections is that at which it is anticipated the mound will be ultimately permanent in form, but this, of course, cannot be guaranteed.

11. The point 2,200 is the limit to which the existing work can be utilized as a built structure. Since the storm of November 1881 the upper blocks have been tied together with pieces of bent railway bars cemented into them, and the top has been levelled with concrete. Nothing more will be done till, as a final operation, after the whole length of the piers shall have been completed, the capping of concrete in mass about six feet high recommended by the committee is placed upon it.

12. From this point forwards the system of construction will be in a certain sense reversed. Instead of placing a new wave-breaker in front of the old work, the old work will be treated as part of the wave-breaker, and a new wall constructed inside it. By this arrangement the old work will be utilized to the fullest extent, while in the execution of the new work the elements of uncertainty will be reduced to a minimum. It will be a continuance of the system of work hitherto carried on with much success as an executive operation, and of which the cost is well

known. Some modifications and some special works, however, will have to be introduced, which to a small extent will involve new conditions.

13. The mode of passing from one system to the other is shown upon the plan. The old building is standing complete to 2,200, and from that point the new building will commence as a complete section, but in order to form a continuous line along which the setting machines and the blocks and other materials can pass without interruption, it is proposed to build a wall 12 feet wide for a length of 160 feet back, starting at 2,040. This wall will curve away from the old wall (the space between the two being filled in with rubble and concrete) till sufficient space is gained to build the section to the full width of 24 feet.

14. The new building will be of the same general character and dimensions as its predecessor, but there will be some modifications of detail. The original building consisted of two independent walls placed in contact, but not tied together. It is recommended that for the future the blocks should be bonded together, so as to form one wall, and in this recommendation I concur. The unbonded system has great advantages in comparatively shallow water, in which the waves have little effect on the blocks themselves, but much on the foundations, while in deeper water the action of the sea on the foundations is less, but that on the blocks themselves is greater, and this fact turns the scale in favor of bond for the outer portions of the piers. At the same time the bond rather increases in some respects the difficulties inseparable from a compressible foundation, and new difficulties are introduced by the special circumstances of the case.

15. It will be seen from the sections that the new rubble base will be deposited over the inner slope of the old, and upon that slope some of the overthrown blocks are lying. All the blocks which lie under the line of the new building will have to be removed, either bodily or by blasting, for if they are allowed to remain they will cause inequalities in the settlement, which will be highly injurious to the superstructure above. In order to avoid these blocks as much as possible I have increased the distance at which the committee proposed to place the new pier from the old one by 9 feet, and this will also place the line of new building more clear of the old rubble.

16. But even with these precautions of removing the old blocks, and increasing the distance from the old work, there will still be a greater liability than there was in the original work to unequal settlement. The sea side of the new building will still partially rest on the old rubble, which has been consolidated by four or five years' exposure to the sea. The new rubble will be in the same position as the old was when first built upon, that is, it will be liable to be compressed to the extent of a foot or 18 inches within a few hours after the weight of the blocks is placed upon it, and to a slower settlement subsequently extending over months, and perhaps years. This latter slow process of settlement, however, is not injurious to the work. But the first is so, it subjects the blocks to great and irregular strains, and is, I think, the most fruitful cause of many of the original blocks having been broken. The evils would be materially aggravated by the fact of one side being more liable to settlement than the other.

17. It is, however, possible materially to reduce these evils, if not to prevent them altogether, and it is proposed to do this by subjecting each length of bed after it is prepared by the divers, and before the blocks are set, to a compression rather greater than that of the blocks themselves. This will be accomplished by placing in front of the work a pile of iron (old rails, with the interstices filled up with cheap cast-iron bars), covering the same area as a row of blocks, and having a weight rather greater than that of the blocks. This "compressor" will be moved forward in advance of the building by the Titan. If, after its removal, it is found to have compressed a bed unequally, the hollow parts will be fitted up with suitable flat pieces of stone before the blocks are set.

18. I propose to introduce another departure from the original design, which will also diminish the evils of settlement. In the original work the foundation blocks were 6 feet high, and above this there were three courses of blocks, each 8 feet high, the whole being 41½ feet wide. It is intended now to use blocks 6 feet high and 6 feet wide, of which there will be five courses, including the foundation course. These blocks will be stronger than those 4½ feet wide, and less liable to break. There is also the incidental advantage that the iron compressors would have to be advanced in stages of 6 feet instead of 4½ feet, and this would accord better with a fair rate of progress of one row per day.

19. It will be seen by the cross sections that the foundation course consists of two blocks of equal length (each 14 feet), the upper courses of blocks of 14 and 10 feet alternately breaking joint. Thus the foundation course will not be bonded. The reason for this is that there would be a practical difficulty in manipulating both the 16 feet and the 12 feet blocks in that situation. I pointed out these difficulties to the committee, and obtained their concurrence to this small departure from their recommendation. The importance of bonding is greatest in the top course, and diminishes in descending. In the bottom course it is practically *nil*.

20. The blocks will be further locked together by means of a projection on the top of one block fitting into a corresponding recess in the bottom of the block above. This principle was adopted in the original work, and was certainly successful in preventing the blocks from sliding on one another, as they had been found to do at Kurrachee and elsewhere. In the present case a

connection of a similar kind will be made between the ends of the 14 feet blocks on one side with the ends of the 14 feet blocks in the courses above and below on the other side, which overlap them, and there will also be hollows and projections on a somewhat similar principle in the backs and faces of the two top courses, thus giving additional ties throughout the whole width. A further tie will be given by means of a bent rail cemented into the two blocks of the top course in every row, but the cramp which is shown in the committee's sections in the second course from the top may, I think, be dispensed with, in consideration of the additional ties provided by the projections and hollows in the blocks themselves. The cramp could be only very imperfectly fixed, as it would be constantly in the wash of the sea, and the necessity of fixing it before setting the top course would be a serious obstruction to the work.

21. There will be an interval of about 45 feet between the face of the new wall and the back of the old one, and in this space the great bulk of the overthrown blocks are lying. The remainder of the space will be filled up with random blocks to form the wave-breaker, of which the remains of the old work will form the sea slope. Any of the old blocks of the two upper courses that remain in place will be removed to the body of the wave-breaker so as to leave the sea face fairly uniform. The two lower courses, of the sea wall at any rate, are very nearly perfect and will form a continuous toe to the slope of the wave-breaker very much as shown in the average section from 2,600 to 3,800.

22. There are now in stock 800 blocks which will be available for use in the wave-breaker. They are not of the best form for the purpose, but they will be used in the under parts where this is not of consequence. About 6,000 additional blocks will be required to complete the wave-breakers, and there will be uniformly 9 feet × 9 feet × 3 feet, and weigh 30 tons each.

23. The same system of work will be continued to the pier head, but the new built work will be curved round as shown on the plan, so as to avoid a great mass of fallen blocks among which the "Titan" is lying embedded, and also to obtain an entirely new foundation for the additional 50 feet of length required to obtain the narrower entrance. The old pier head is standing with the lower courses almost perfect, the interval between the ends of the old and the new work will be built up with a solid wall of concrete blocks, and the enclosed space behind filled in with random blocks. The last 200 feet of the new pier, including the portion facing the entrance, will be made 38 feet wide, instead of 24 feet, and will be founded 12 feet lower than that within the harbour, or 34 feet below mean sea level. Its toe will be protected by an apron of concrete blocks laid on the foreshore.

24. The work at the south pier will be generally similar to that at the north, except that, in consequence of the advance of sand, the protection works need not be commenced so near the shore, and there is no place requiring special protection like that proposed for from 200 to 250 at the north pier. There has been some advance of the sand since the date of the latest survey (1882), and in execution rather less work will be required than is shown upon the accompanying plan and sections, but for the present I have thought it better to base my estimates on the latest complete survey.

25. According to this then the protection by concrete blocks will commence at 1,000, and will gradually increase up to a high-water width of 20 feet at 1,300, where the depth at high water is 25 feet. It then continues with the width gradually increasing to 28 feet at 2,550, up to which point the existing pier is perfect.

26. At 2,550 the new pier commences, being connected with the existing work in the same manner as at the north pier, and is carried on to the head with only such variations as the different circumstances require. The line shown on the plan passes between the overthrown blocks and the Titan. The Titan is not in this case encumbered with blocks, and can be removed by blasting if it should be necessary to do so. The new head will be connected with the old one in the same manner as at the north pier. The difference in the form of the two heads is rendered necessary by the different positions of the fallen Titans, but there is no objection to it, as it will be scarcely noticeable from any accessible point of view.

27. I estimate that the above works will require 3½ years from the recommencement of blocksetting in June next, or till about the end of 1888. The estimated cost is Rs. 45,90,051, including 7½ per cent. for establishment, and 2½ for contingencies, but this estimate does not give a basis for determining the total cost of the harbour as completely restored, without taking into account the expenditure since the storm of November 1881, and the relation of that expenditure to the previous outlay on the one hand, and to the future outlay on the other, I shall show (in paragraph 42 *post*) that a sum of Rs. 2,96,334 has been already expended on works and materials included in this estimate.

28. The total expenditure up to 31st October 1881 was Rs. 58,72,082 including Rs. 1,53,945 expended in the purchase and partial fixing of moorings which were the subject of a different sanction from that of the harbour works proper. It also included the value of certain materials which had been acquired for the completion of the work and are still available.

29. Between 31st October 1881 and 30th April 1884 Rs. 9,08,088 have been expended, and regular monthly statements purporting to account for the details of this expenditure have been

regularly submitted to Government, but as, in conformity with the inflexible rule of the Public Works Department system, all charges are referred to heads for which there is a corresponding sanctioned estimate, the accounts would show that expenditure has gone on increasing for works to which no addition has been made. It is obvious that the present form of the accounts can only be viewed as provisional, and that any real explanation of the expenditure must be based on an entire re-arrangement of the statement.

30. At my request Mr. Thorowgood has made such a re-arrangement, of which I append a copy (appendix A). From this it would appear that the total expenditure may be classed as follows:—

	Rs.
1. Actual work, and purchase of materials for work	4,43,972
2. Purchase of land threatened with erosion, and compensation for land washed away	2,58,075
3. Establishment, and salaries of foremen under agreement ...	2,06,041
Total ...	9,08,088

But as the first and second of these items were incurred under the superintendence of the harbour works' staff, they should bear their fair charge for the cost of such, which I place at 10 per cent. for the first, and the sum of Rs. 6,650 (the actual salaries of the persons employed) for the second. With these corrections the items would stand thus:—

	Rs.
1. Actual work, &c.	4,88,369
2. Purchase of land, &c.	2,64,725
3. Establishment. Cost during suspension of work	1,54,994
Total ...	9,08,088

31. Now I would submit that the last two of these items, although fairly debitable to the harbour *undertaking*, are not fairly chargeable to the *works*, and should be kept distinct in any statement of expenditure. I shall have occasion further on to explain the circumstances under which the outlay under the second head was incurred, and I will only now say that it ought to appear in a statement of gain and loss of land, in which there is a credit as well as a debit side. With regard to the third, I need only say that to add it to the item of "Establishment" in the accounts of either the old or the new works could only mislead. I submit that it should appear as an item by itself.

32. There remains to be accounted for the sum of Rs. 4,43,972, or, including cost of management, Rs. 4,88,369, little more than half the total of the official statement. This may be classed under four heads, as under:—

	Rs.
A. Stone revetment for protection of shore north of harbour ...	1,13,618
B. Expenditure debitable to the original design	1,17,769
C. Expenditure consequent on the storm of November 1881 ...	39,509
D. Expenditure in anticipation of the restoration works	1,73,076
Total ...	4,43,972

33. The first of these items is part of a total of Rs. 2,04,627 expended on this object and hitherto charged to "Contingencies." I think it might fairly be placed in the same category as the purchase of land, for which it is simply an alternative, but, at any rate, it should be kept apart as an exceptional item of expenditure.

34. Item B consists of Rs. 75,029 expended on levelling and clamping the injured portions of the piers, and this would have been done even if the remaining portions of the work had not been damaged by the storm; Rs. 15,328 is the expenditure on moorings in the month of November 1881 previous to the storm. The remainder of this item, Rs. 27,412, covers Rs. 16,013 expended on an extension of the town sewer at a spot more than half a mile from the harbour, and chargeable to the harbour funds on rather questionable grounds. This leaves Rs. 11,399 for various small contingent expenses.

35. Item C consists of Rs. 16,485 expended in clearing away the wrecks of the two hopper barges sunk in the storm, and this has to be reduced by more than half of a sum of Rs. 12,835 (the proceeds of a sale of the recovered materials of the barges and some other old materials not easily separable); Rs. 17,803 expended on the recovery, removal, painting, and tarring and stowing away for future use of mooring materials, and Rs. 5,221, repairs to private property damaged in the storm.

36. Item D consists of Rs. 87,230 for new concrete blocks, Rs. 58,079 for various repairs and renewals of plant and machinery, and Rs. 27,767, the net increase in the value of unissued stores and materials since November 1881. The expenditure under this item (D) are charges against the estimate for the restoration works.

37. I have appended (appendix B) a statement of the total expenditure from the commencement of the works to 30th April last, classified under five principal heads, which I would submit for adoption in future accounts. The following is a summary:—

Sanctioned estimate. Rs.	Name of account.	Expenditure. Rs.
56,50,000	I. Original design	56,57,840
2,00,000	II. Moorings	1,90,589
	III. Cost of establishment during suspension of works	1,54,994
	IV. Gain and loss of land	4,82,114
	V. Restoration works	2,96,334
	Total as per official return ...	67,81,871

38. The first of these, I would suggest, may be considered a *closed account*. The official statement of expenditure up to 31st October 1881 has been amended by the addition of such subsequent works as are fairly debitable to the design, and by the removal from it of charges which must still be kept open, some being transferred, as shown in the appendix to account IV and some to account V.

39. The second (moorings) must be kept open, but no further expenditure will be incurred till the restoration works are further advanced. An amended estimate, though not a very large one, will then have to be submitted.

40. The third (cost of establishment during suspension of works) I would suggest should be treated as a *closed account*. A liberal allowance has been made for the legitimate cost of superintendence of such works as have been going on during the general suspension, and the sum of Rs. 1,54,994 is the remainder.

41. The fourth (gain and loss of land) I shall explain more fully further on, and show that it should be treated from henceforth as one side of a Dr. and Cr. account.

42. The fifth will be absorbed in the regular accounts of expenditure on the restoration works, and will appear under the proper heads. Sanction is asked for an estimate of Rs. 45,90,051, against which this amount of Rs. 2,96,334 will be the first charge. The estimate itself, in the form which I submit for adoption, is given in appendix C.

43. I beg now to return to the subject above named, the gain and loss of land. This subject has been treated in former reports as the "sand difficulty" and the "changes of the coast line," but the two latter descriptions are now imperfectly applicable to it, while the first represents the result which is now most prominent.

44. It will be remembered that from the commencement of the works it became manifest that there were movements of sand up and down the coast in opposite directions in the two monsoons, of which the movement from south to north during the south-west monsoon was the greater. This movement being obstructed by the harbour piers the result was an annual advance of the shore line on the south of the harbour, and an annual retreat of the same on the north. The plans show the former in its successive steps for the last seven years. Each blue line shows the most shoreward position of high-water mark for the year. It advances every year from about March to about October, and then retreats from October to March. The rate of increment decreases with fair regularity from year to year, as the length of shore to be covered and the depth of water to be filled increase. It is clear on the one hand that there is no indication of a limit to the advance, and on the other that, considering the decreasing ratio in the rate of advance, the time when it will be injurious to the harbour is still very remote. The area of land gained from the sea up to the present time is 70 acres.

45. Within the harbour there has also been an advance of the shore line, but this took place almost entirely during the years 1876 and 1877, when the north pier formed the only barrier to the northerly movement, the south pier not having then advanced sufficiently to arrest it. Since the latter year there have been some variations in the positions of the high-water line, due to local causes, but no persistent annual advance. The area of land gained within the harbour is 18 acres.

46. To the north of the harbour the result is as might be anticipated, the reverse of that to the south. The preponderating northerly movement of sand causes an annual erosion instead of an accumulation. But the progress is much less regular. This is due to two causes, the one natural, the other artificial. The natural cause is this. The sand within the influence of the waves is subject to two distinct movements, the alongshore movement due to the oblique stroke

of the wave (and this is greatest in moderate weather), the other a transverse movement which is *on* or *off* shore according as the wind is *off* or *on* shore. Thus the *off* shore wind in itself accumulative all along the coast acts with an accumulative alongshore movement to the south, and an erosive movement to the north, and the *on* shore wind of the remainder of the year, erosive all along the coast, acts with the erosive alongshore movement to the south, and the accumulative to the north. Hence the forces are in both seasons acting in concert to the south, and in opposition to the north, and the result is much greater irregularity in the annual changes where they are in opposition.

47. The artificial cause of irregularity is that whenever erosion is manifested protective measures are naturally at once taken, and these counteract the local erosion, even if they drive it to some other locality. As a whole, however, the protective measures appear to have been efficient, for while the gain of land to the south of the harbour has been, as already stated, 70 acres, the loss to the north has been only 41 acres, and this, of course, entirely beyond the limit of the protective works.

48. For the above reasons the conclusions to be drawn from the records of erosion north of the harbour are much less definite than those drawn from the records of the accumulation to the south. We know that erosion is going on, but both the rate of it and the locality for the future are very uncertain. Nevertheless, I think a provisional settlement has now been made upon a tolerably satisfactory basis, and I would ask for a confirmation of it.

49. To explain the present state of the question I must go back to the early stages of the work. The part of the shore affected extends for about two miles northward from the north pier. For three quarters of a mile there was a made road along the shore, and on the landward side of this road stand in succession the Madras Railway Company's Rayapuram terminus and offices, the Biden Seamen's Home (these are shown on the plan), some merchants' godowns, a first-class bungalow and compound belonging to the late Honorable J. G. Coleman (lately purchased by the Government), and a cluster of small brick-built native houses. Beyond this there was no regular road, but the shore was occupied by hut villages, with few permanent buildings, and timber yards. A little inland are five second-class bungalows standing in compounds having a depth of some 400 feet, beyond which is a good road parallel with the shore. To the northward of the last of these bungalows is a native village with a bazaar, but few permanent buildings, and beyond this agricultural land.

50. As the north pier advanced into the sea in 1876 the first effects of erosion were felt opposite the railway terminus. These were immediately met by the deposit of stone and bags of concrete, and little inconvenience resulted. As the pier advanced further seaward the locality of erosion was thrown further to the northward, and the protective works assumed the form of a continuous stone revetment between the road and the sea, and upon this had been expended up to 31st October 1881 the sum of Rs. 91,009. It extended to a point 3,450 feet from the north pier and a little beyond Mr. Coleman's property.

51. The storm of November 1881 showed, as had been anticipated, that this revetment required an addition of stone, as the first was worked into the sand by the action of the sea. Some of the buildings close to the road were damaged, and were repaired at the expense of the harbour works, but, on the whole, the results of the storm were not serious so far as the revetment extended.

52. But the question was now prominently presented: How far is this protective revetment to be carried? It was effective as far as it went, but costly, and it became evident that it would be possible to spend more in protecting the land than the land itself was worth. In the early part of 1882, therefore, while at Madras, I investigated this question, and satisfied myself that though the revetment was fully justifiable as far as it had gone, for up to that point the evil of erosion would be even greater than the loss of the value of the land, this would not be the case much further on. I therefore recommended that the existing revetment should be strengthened, and that it should be extended northwards sufficiently to make a fair junction with the new line of shore, but that beyond that no further protection should be attempted. All the land abutting on the shore for some two miles northward should be purchased by the Government, so that no further questions of compensation to private owners should arise.

53. These recommendations have since been carried out. The revetment has been completed and extended at a cost of Rs. 1,13,618 and 140 acres of land have been purchased, or its loss compensated for, at a cost of Rs. 2,59,475, and these sums, together with the Rs. 91,009 spent on the original revetment, and the cost of management, make up the sum of Rs. 4,82,114, which I put forward in paragraph 37 as the *debit* side of the "Gain and Loss of Land Account."

54. I have now to show on what the credit side of this account will be based, and while I allow that the great bulk of this is still in the future, yet I submit that the longer the opening of the account is delayed the greater will be the difficulty in establishing it.

55. I have mentioned that 140 acres of land were purchased; of these 41 have been washed away, so that 99 acres remain. The rents of these are collected, and under present orders are to be credited to the harbour works funds. These at any rate should be placed in the new account.

56. Then there have been gained within the harbour limits, as stated in paragraph 45, 18 acres of land. A great part of this has been utilized, and two large godowns have been erected upon it by the Marine Department for port revenue purposes. The value of the accommodation thus given should be credited to the same account, either by the land being transferred to the Marine Department at its fair value, or by an annual payment proportioned to the use made of the land. This payment would no doubt increase from year to year.

57. To the south of the harbour 70 acres have been gained. The Commissariat Department have appropriated an advantageous site, which, five years ago, was in the surf, on which a building, 200 feet by 120 feet, has been erected. Another site has been appropriated in a similar manner by the Marine Department, on which was erected a shed for horses landed from ships. Other buildings of the same kind will no doubt follow, for the situation is a valuable one, and though it is no doubt gratifying to see it utilized, it is somewhat inconsistent that the outlay by which it has been acquired should be debited to one department, and the returns credited to another.

58. The above are Government appropriations, but private individuals are also profiting by the new site. The dealers whose timber yards north of the harbour were purchased at a high price out of harbour works funds are occupying the new beach south of the harbour for the same purpose *rent free*, or if rent is paid it is not credited to the harbour works accounts.

59. I am well aware that if revenue were collected from the sources I have indicated it would make at present but a small show in comparison with the expenditure, but it is certain that it would increase, and it is also desirable that the new land should be recognized as a property which has been acquired by the Government, at a cost of nearly five lakhs of rupees, and that some control should be exercised over its occupation. I would add that I am about to point out a mode of utilization of a portion of a site which would ultimately add materially to the value of the whole.

60. I would now beg to submit some remarks on the future utilization of the harbour, which, although they can only be followed up by definite recommendations for immediate action to a small extent, are, I think, especially called for at the present time, because the subject has been lately under discussion from another point of view. A proposal had been made to alter the position of the entrance, with the view of obtaining stiller water in the harbour, but as this proposal was not approved by Sir John Hawkshaw, Sir John Coode, and Professor Stokes, on reference to them by the Secretary of State, it may now be considered at an end. It is only necessary for me to say that I concur in their conclusion, and I only refer to it now as giving a suitable occasion for pointing out what may be done for improving the accommodation of the harbour with the entrance in its present position.

61. The main points to be kept in view are—

I.—The safety of ships.

II.—The facility for loading and discharging cargo boats alongside the ships.

III.—The facility for loading and discharging cargo boats at the shore.

IV.—The safety of cargo boats and other local craft in bad weather.

62. With regard to the safety of ships, I think it is now generally understood, though it may be somewhat inconsistent with the popular ideas upon the subject, that a harbour may be very useful, even though it may not be a place of absolute safety in the heaviest storms. If Madras were a terminal port, such as London or Liverpool, or even Calcutta or Bombay, the want of absolute safety would be a serious drawback, but Madras is essentially a port of call, where ships only remain for a day or two, and are never dismantled. A steamer's fires are never let out during her stay in the port, and no sailing ship would ever be admitted, unless in very settled weather, without every facility being provided for her leaving at an hour's notice, and in any wind. To be caught in a cyclone at Madras, therefore, is no more than to be caught in a cyclone in mid ocean, provided always that the ship can get to sea. This then is the provision that is wanted, and not a safe mooring in the height of the storm.

Now, it must be remembered that the dangerous storms in the Bay of Bengal never come without notice, but occasionally, indeed frequently, the notice comes without the storm following. This is a source of inconvenience, because precautions have to be taken upon the *notice*, before the actual advent of the storm, when they would be too late. Hence it happens more often than not that when ships are sent to sea they return without having met with the expected storm.

63. But this is an inconvenience which may fairly be expected to be lessened as the indications of storms are better recorded, and the actual courses of existing storms are more perfectly traced. Even as it is, however, the inconvenience is not an intolerable one, and may be taken as an infinitesimally small deduction from the real value of the harbour. During the last two years there have not been more than four or five occasions on which ships have been warned to sea, and not one on which they would have been in actual danger if they had remained at their moorings in the harbour, mutilated though it be. Yet, during all this time, every single steamer has come into the harbour to load and discharge, and paid dues for doing so.

64. It must be admitted that, in one respect, a ship is worse off in the harbour than anchored in the roads outside. She must put to sea at an earlier stage of the warning for bad weather, as the confined space increases the difficulty of manœuvring the ship with a rising wind and sea, setting probably from different quarters. But this is an evil which will certainly diminish with more complete mooring and warping appliances, and more local experience on the part of the marine officers, and it does not touch the question of the ultimate safety of the ship. It has sometimes been asserted that the harbour is a trap from which escape would be impossible. It might perhaps be so once in 10 years if the commander of the ship, and the whole staff of the Marine Department and the Meteorological Observatory, were simultaneously to neglect the most ordinary and well known precautions, but, under existing conditions, such an idea is inconceivable.

65. I submit, then, that the demand for absolutely safe berthage for ships in the height of a cyclone is based rather on sentimental than on practical grounds. The harbour introduces no new element of danger. All that can be said is that, while it gives many new advantages and remedies many evils, it leaves one evil of very rare occurrence untouched. It is right to add that I do not think even this one evil is irremediable at some future time, but at present the circumstances of the port would not warrant the necessary outlay.

66. With regard to the second point, the facility for loading and discharging cargo boats alongside the ship, the advantages of the present over the old system are obvious. Under the old system the ship was anchored at a mile or upwards from the shore to a single anchor, so that she swung with her head to the wind or the current whichever might be the stronger, and rolled to the swell which generally comes from a third quarter. A more "uneasy" position for a ship, even in ordinary weather, it is difficult to imagine, and all around her, while subject to these conflicting disturbances, the cargo boats had to crowd. These boats again were subjected to yet another disturbance, the wind waves, which would scarcely affect the ship except indirectly by constantly driving the boats against her sides. Under these circumstances cargo had to be transferred to and from the boats. Then the boats had to be rowed out and back by manual labor (11 men to a boat carrying two tons) over this mile, and through the surf. The whole operation was one of little danger but of great cost, both in the labor employed, the damage done to goods, and the detention of the ships.

67. Now compare this with the present system. The ship is now brought to within a quarter of a mile of the shore; she is completely out of the current, and, being moored head and stern, is not affected by the wind; her head faces the swell. The wind waves which tossed the boats outside the harbour are much reduced, so that the latter are far more manageable. I mention these details to show that the advantages afforded by the harbour are by no means confined to a reduction of the on-shore swell. Even if this were disregarded altogether (and even those who are loudest in their disparagement admit *some* reduction), the advantages which remain are sufficient to explain the reason of the notorious fact that ships are eager to enter the harbour. Of course it is fully admitted that the more the swell can be reduced the better, but to make this one object paramount is altogether to misrepresent the case.

68. With regard to the loading and discharging cargo boats at the shore, the advantage gained so far is simply that due to the reduction of the waves, whatever that may be. In itself it is not much, but the stiller water enables improvements to be made which would have more effect. The existing screw-pile pier was made for open sea work, and it has inconveniences which are inseparable from such work. The principal one of these is its great height (about 18 feet) above water. With constant smooth water a height of 6 feet would be sufficient, and obviously much more convenient.

69. A few months before the storm of November 1881 two new low level jetties were actually commenced, with the intention that they should for a time supersede the screw-pile pier, which was itself to be altered and adapted to the new circumstances, and again brought into action when required as an auxiliary to the new jetties. The storm put an entire stop to this scheme, at any rate till the harbour is restored, and if it is then revived it must be with considerable modifications. But this scheme was after all only the best under circumstances then existing. New circumstances have since arisen, and another scheme must be adapted to them.

70. Such a scheme may be found in the modification in the system of working the existing pier. The complaint first made was of the great height cargoes had to be lifted, but, in reply to the obvious suggestion that the employment of steam cranes would remedy this evil, the further complaint was started that, even if the goods were lifted more quickly, they could not be removed from the pier on the existing line of railway. Now the pier is 40 feet wide. It contains four lines of railway of 5 feet 6 inches gauge. Upon the same width six lines of metre gauge could be placed. These two additional lines of railway would relieve any conceivable amount of block. All that is wanted, therefore, to *treble* (I think I may safely say) the present accommodation of the pier is to expend fifty thousand rupees on three or four steam cranes with a quick motion, a sufficient stock of narrow gauge trucks, and materials for two extra lines of railway. It is no part of the present duty of the harbour works staff to work out the details of such a scheme, but I have no hesitation in saying that some such would be a perfect solution of any existing or probable difficulty in the landing and shipping of goods at the shore.

71. The last point which I named in paragraph 61, the safety of cargo boats and other local craft in bad weather, is, in my opinion, the most important of all. As I have already shown ships have a refuge at sea, but this is not available for local craft. If they cannot safely ride at anchor they must be hauled up on the beach. This necessity obviously limits the size of the craft to be employed. Masula boats carrying two tons can be beached even when loaded. The cargo boats carrying 12 tons, which were introduced after the screw-pile pier was built, can be beached empty, and were formerly so placed in safety during the two bad weather seasons of the year; but for lighters of 60 to 100 tons, which are essential to an economical system of landing and shipping cargo, for a steam tug, for a floating derrick for lifting heavy articles, and for other craft for which a demand is sure to arise, beaching for purposes of safety is not practicable; safe floating berths must be provided.

72. I had certainly formerly anticipated that craft of this description might have safely lain at anchor within the harbour even in the worst weather, but I am not prepared to resist the impression to the contrary which was produced by the effects of the late storm. It may be that that impression will be removed or modified by further experience of future storms, when the breakwaters are more efficient and the opening for the entrance of the waves reduced; but for the present I will assume that, on the threatening of a cyclone, the present area of the harbour must be cleared by the sea-going ships going to sea, and the local craft in another direction. What is this direction to be?

73. The 70 acres of land gained to the south of the harbour and described in paragraph 44 of this report seem to suggest an answer to the question. It will be seen from the plan that, in March of this year, the high-water line outside the harbour was nearly continuous with the two-fathom contour inside. Two years hence it may be safely predicted that it will be something like 100 feet further out. Now, a dock or basin 1,000 feet long, 300 feet wide, and 10 feet deep at low water, with an opening through the pier into the harbour 60 feet wide, covered by a jetty of concrete blocks running northwards from the pier for 300 feet, would provide accommodation for the whole of the local craft, and would cost, including a stream dredger for the excavation, about 1½ lakh of rupees, and for an additional half lakh the area of the basin could be doubled.

74. I do not suggest this for immediate execution. Craft too large for hauling up on the beach should not be introduced till the harbour is somewhat more complete, but I point it out in general terms as the direction in which the harbour may be extended, and developed to a great extent. The basin would be, in the first instance, a mere place of shelter, but a boat wharf would soon be established on its landward side, and the frontage would become valuable. As the high-water mark advances seaward the basin would be widened, and in course of years its seaward margin would be so near the deep water in the harbour as to suggest the possibility of a ship entrance. With such capabilities in the site which has been added to the harbour property I submit that I am justified in anticipating advantages which will go far to compensate for some disappointment in the degree of stillness obtainable in the area of the harbour itself, and an equivalent for the five lakhs expended in protecting and purchasing land to the north.

75. It is right to state that the idea of the necessity of boat shelter is by no means new. It was urged years ago, and among others by the present Master Attendant, Captain Taylor, as the real want of Madras, and, in the visits I have paid to several other ports of India, I have found that the cost of landing and shipping cargoes is less dependent on the condition of the ship's anchorage, as to exposure or distance from shore, than upon the power of employing larger or smaller cargo boats, and this in its turn depends on the facilities for giving them shelter. But it must be remembered that at Madras a boat harbour would have been impracticable on account of the movement of sand along the shore until works had been carried out far enough into deep water to stop the sand and at the same time to form a ship harbour.

76. I may further suggest that this boat harbour would form the most convenient access to a line of water communication with the Buckingham Canal, and the extensive system of inland navigation in connection with it. The distance is about a mile, and the intermediate ground is almost entirely unoccupied.

77. As the foregoing report has dealt with a variety of subjects, it may be convenient if I conclude by a concise *resumé* of its contents.

Paragraphs 1 to 26 are devoted to a description of the proposed works of restoration.

Paragraphs 27 to 42 contain an analysis of the expenditure especially since the storm of November 1881, and paragraph 37 contains my recommendation as to the apportionment of the items of expenditure to five several heads.

Paragraphs 43 to 59 deal with the question of gain and loss of land by the accumulation and erosion of the sand on the coast.

Paragraphs 60 to 75 deal with the utilization of the harbour, 62 to 65 having reference to the means for ensuring the safety of ships, 66 and 67 to the transfer of cargo between the ships and the boats, 68 to 70 to the loading and discharging of boats at the shore, with a suggestion in paragraph 70 for an immediate improvement of the system of working on the screw-pile pier, 71 to 75 to the safety of cargo boats and other local craft in bad weather, with a suggestion in

73 and 74 for the future utilization of the land gained to the south of the harbour by the formation of a boat harbour.

Paragraph 76 suggests that a communication may ultimately be established between this harbour and the inland canals.

78. In the appendices will be found the following :—

A. Mr. Thorowgood's re-arrangement of the accounts of expenditure from October 1881 to April 1884.

B. Abstract of expenditure from commencement of works to 30th April 1884.

C. Estimate of restoration works as recommended, with statement of expenditure in respect thereof to 30th April 1884.

I have, &c.,

(Signed) W. PARKES.

APPENDIX A.

Madras Harbour.

Analysis of Expenditure between 31st October 1881 and 30th April 1884 by Mr. Thorowgood.

			Rs.
Total expenditure shown in accounts, 30th April 1884			67,69,036
Add recovery on sale of plant and materials			12,835
Total expenditure, as shown 31st October 1881		Total ...	67,81,871
Add for work done in November 1881, south pier rubble	58,72,083		
	1,200		
Add further for recoveries on "concrete blocks" in north and south piers (of which Rs. 296 is accounted for)	58,73,283		
	300		
		58,73,583	
Total difference to be accounted for ...			9,08,288

Expenditure.

1. Additions to existing pier works :—			
Concrete topping, clamping, and railways—			
North pier		44,088	
South pier		27,080	
Rubble foreshore and repairs to surf banks—			
North pier		3,861	
South pier		...	75,029
2. Recovery and destruction of hopper barges			16,485
3. Recovery and painting mooring gear, exclusive of cost of four pontoon boats (Rs. 8,465)			18,003
4. Rubble stone revetment, north beach			1,13,618
5. Repairs to buildings, damages by sea			5,221
6. New concrete blocks			87,230
7. Repairs and renewals to machinery and plant, transferred from other heads as below :—			
Concrete blocks		19,082	
Setting blocks		8,819	
Revetment, north beach		1,859	
Moorings		2,000	
North pier, repairs		2,459	
South pier, do.		1,933	
North pier, foreshore		1,766	
South pier, do.		4,552	
Pontoons (item 3)		8,465	50,935

				Rs.
7a. Actual charges under "General Tools" between November 1881 and 30th April 1884, as shown in accounts				7,144
Total to this point ...				3,73,665
8. Establishment taken at 7½ per cent. on the above total ...				28,010
9. Contingencies (including intercepting drain)				27,250
9a. Police, conservancy, and lighting				3,307
10. Compensation paid for land washed away				52,181
11. Purchase of land north of harbour				2,05,894
12. Establishment on items 10 and 11, estimate at Rs. 350 a month for 19 months (nearly 2¾ per cent.)				6,650
13. Taking total establishment charges, as shown in accounts, and adding charge for establishment during suspense, transferred as below, deduct from this total, items 8 and 12 and there remains establishment during suspense				1,68,074
Total charge to 30th April 1884			5,10,809	
31st October 1881			3,51,004	
			1,59,805	
Add from—				
North pier rubble		1,766		
Setting blocks		8,819		
North pier, sea damage		4,918		
South pier, rubble		4,552		
South pier, sea damage		1,932		
Concrete blocks		19,082		
Revetment		1,860		
			42,929	
			2,02,734	
			Total ...	8,64,831
Add to this—				
Stone lying at quarry			4,659	
Stores on hand			23,108	
Payments for moorings in accounts of November and December			15,328	
Item No. 34 in account sheet			162	
			43,257	
			9,08,288	

Note.—The above is the basis of the statement forming appendix B, but the items have been further re-arranged to some extent, which accounts for some differences in the figures, though the total amounts will be found to agree.

W. PARKES.

APPENDIX B.

Madras Harbour Works.

Abstract of Expenditure from Commencement of Work to 30th April 1884.

Estimates.	Description of Work.		Expenditure.
	(I) *Original Design.*		Rs.
	Expenditure to 31st October 1881	57,18,137	
	Do. in November „	1,500	
	Supplementary protection works	75,029	
	Contingencies	27,412	
	Recovery of wrecks and repairs of storm damage	21,706	
	Establishment, 10 per cent. on Rs. 1,24,147 ...	12,415	

Abstract of Expenditure from Commencement of Work to 30th April 1884—*cont.*

Estimates.	Description of Work.			Expenditure.
				Rs.
	Deduct (transferred to IV and V)—			
	To IV, Revetment	91,009		
	„ IV, Purchase of land	1,400		
	„ V, Concrete blocks	40,281		
	„ V, Stores	65,669		
			1,98,359	
Sanctioned, Rs. 56,50,000	Net expenditure on original design			56,57,840
	(II) *Moorings.*			
	Expenditure to 31st October 1881		1,53,945	
	Do. in November 1881		15,328	
	Subsequent expenditure		18,003	
Sanctioned, Rs. 2,00,000	Establishment, 10 per cent. on Rs. 33,133 ...		3,313	
	Expenditure to 30th April 1884			1,90,589
Submitted for sanction, Rs. 1,54,994	(III) *Cost of Establishment.*			
	During suspension of works			1,54,994
	(IV) *Gain and Loss of Land.*			
	Gained, 88 acres; lost, 41 acres.			
	Protection: Revetment previous to October 1881		91,009	
Submitted for immediate sanction, Rs. 5,00,000 to be subject to recovery by rents and value of land utilized.	Do. do. subsequent to do.		1,13,618	
	Establishment, 10 per cent. on Rs. 1,13,618 ...		11,362	
	Purchase of land and compensation		2,58,075	
	Do., transferred from I		1,400	
	Establishment expenses		6,650	
	Total to be carried to debit of account			4,82,114
	(V) *Expenditure to be charged against Restoration Works.*			
	Concrete blocks, transferred from I		40,281	
	New do. made since October 1881 ...		87,230	
	Repairs and renewals of plant and machinery.		58,079	
	Consumable stores on hand October 1881, transferred from I		65,669	
	Do., balance of additions and issues since October 1881		27,767	
	Establishment, 10 per cent. on Rs. 1,73,076 ...		17,308	
	Total to be carried to debit of account			2,96,334
	Total expenditure to 30th April 1884, as per official return.			67,81,871

21st August 1884.

W. PARKES.

APPENDIX C.

Madras Harbour.

Estimate of Restoration Works.

—	Amount.	Amount.	Expenditure to 30th April 1884.
Preliminaries.	Rs.	Rs.	Rs.
New machinery from England	1,74,050		
Repairs and renewals of old machinery	72,479	...	58,079
Alteration and extension of block grounds	10,000		
Railway materials	71,000		
Total preliminaries ...	...	3,27,529	
North Pier.			
Rubble stone in foreshores and base—			
Ordinary deposited from breakwater, 5,532 tons at Rs. 1-8-0	8,297		
Do. from boats, 182,260 tons at Rs. 2	3,64,520		
Large do. under wave-breaker from breakwater, 14,757 tons at Rs. 1-12-0	25,812		
Concrete blocks for building— Rs. A. P.			
Making 58,116 cubic yards at 9 0 0	5,23,044		
Setting 2,062 „ „ 2 0 0	4,124		
Do. 35,245 „ „ 2 8 0	88,112		
Do. 20,809 „ „ 3 0 0	62,427		
Concrete in mass for filling 500 cubic yards at 10 0 0	5,000		
Wave-breaker—			
Built blocks, 288 cubic yards at... ... 10 0 0	2,880		
Ordinary do. 70,849 cubic yards at ... 9 0 0	6,37,641	...	63,756
Depositing do. 70,849 cubic yards at ... 1 0 0	70,849		
Apron blocks, 1,667 do. ... 9 0 0	15,003		
Setting do 1,667 cubic yards at 4 0 0	6,668		
Concrete in bags, 742 cubic yards at ... 12 0 0	8,904		
Cramps, 330 each 10 0 0	3,300		
Concrete capping, 22,400 cubic yards at ... 10 0 0	2,24,000		
Total for north pier ...	...	20,50,581	
South Pier.			
Rubble stone in foreshores and base—			
Ordinary deposited from breakwater, 675 tons at Rs. 1-8-0	1,013		
Do. deposited from boats, 169,517 tons at Rs. 2 ...	3,39,034		
Large do. deposited from breakwater, 15,038 tons at Rs. 1-12-0	26,317		
Concrete blocks for building— Rs. A. P.			
Making 52,113 cubic yards at 9 0 0	4,69,377		
Setting 2,062 „ 2 0 0	4,124		
Do. 29,282 „ 2 8 0	73,205		
Do. 20,809 „ 3 0 0	62,427		
Concrete in mass for filling, 500 cubic yards at Rs. 10	5,000		
Wave-breaker—			
Blocks, making 57,066 cubic yards at ... 9 0 0	5,13,594		
Depositing do. 57,066 do. at ... 1 0 0	57,066	...	63,755
Apron blocks, 1,667 do. at ... 9 0 0	15,003		
Setting do. 1,667 do. at ... 4 0 0	6,668		
Concrete in bags, 742 cubic yards at ... 12 0 0	8,904		
Cramps, 275 each 10 0 0	2,750		
Concrete capping, 19,200 cubic yards at ... 10 0 0	1,92,000		
Total for south pier ...	...	17,76,482	

Estimate of Restoration Works—*cont.*

	Amount.	Amount.	Expenditure to 30th April 1884.
	Rs.	Rs.	Rs.
Materials in store to be debited to works during progress.	...	...	93,436
Establishment, 7½ per cent.	...	3,11,594	17,308
Contingencies, 2½ "	...	1,03,865	...
Lighting entrance	...	20,000	...
Total ...	...	45,90,051	2,96,334

21st August 1884. W. PARKES.

From the Officiating Under Secretary to the Government of India, dated Simla, 28th October 1884, No. 415 M.

Forwarded to the Government of Madras in the Public Works Department for report on the proposals and estimates.

(By Order.)

(Signed) R. B. BUCKLEY,
Offg. Under Secy. to the Govt. of India.

From JULAND DANVERS, Esq., Secretary, Public Works Department, to the Secretary to the Government of Madras, Public Works Department, dated India Office, S.W., 25th September 1884, No. 1433 P.W..

I am directed to transmit herewith, for the information of the Government of Madras, copies of a despatch, No. 56 (together with its enclosures), which the Secretary of State for India has this day addressed to the Government of India relative to the Madras Harbour Works.

From JULAND DANVERS, Esq., Secretary, Public Works Department, to the Secretary to the Government of Madras, Public Works Department, dated India Office, S.W., 10th October 1884, No. 1433/2 P.W.

With reference to my letter of 25th ultimo, No. 1433/1 P.W., I forward herewith the plans (2) referred to by Mr. Parkes in his report on the restoration of the Madras Harbour Works, dated 21st August last.

Office Note from the Examiner of Public Works Accounts, to the Secretary to Government, Public Works Department, dated Madras, 13th November 1884, No. 589.

Your office note No. 1999 D, dated 10th November 1884.

I do not see any objection to the proposed recasting of the heads of account under which the expenditure on the Madras Harbour Works has been recorded. If the re-arrangement be ordered the details can be settled by Mr. Thorowgood in communication with this office.

From J. H. TAYLOR, Esq., Lieut., R.N.R., Master Attendant, Administrative Department, Madras, to the Chief Secretary to Government, dated Madras, 17th November 1884, No. 10562.

With reference to your endorsement, No. 2532, dated 13th November 1884, I have the honor to state that, under the provisions of the Indian Ports Act XII of

1875, the beach is vested in the Marine Department and not the Harbour Works, and accordingly rent is being levied for the same, at the rate of Rs. 6 per ground per month for the storage of timber, the amount being credited to the harbour dues account in order to assist in meeting the interest on the construction of the harbour. The Railway Company alone pay Rs. 3 per ground per month for the ground held by them, as it is at a long distance from the landing place. Mr. Parkes is in error with regard to the value of the sand reclaimed. The principal portion of it is now a lake, and no building could be erected on it, even if other objections did not exist from a military point of view. The horse stockade has no sure existence. It is liable to be washed away in any storm, and the mule stables, which occupy a slightly higher ground, are erected by Government, and the Marine Department has not taken any rent or claimed any jurisdiction over it.

From A. T. ARUNDEL, Esq., President of the Municipal Commission Madras, to the Chief Secretary to Government, dated Madras, 27th November 1884, No. 1595.

In reply to endorsement, No. 2593, Financial, dated 20th November 1884, I have the honor to report that the municipality does not occupy any part of the new foreshore gained by the harbour, nor does it collect rents from any of the timber merchants or other occupants. The collection of such ground rents by the municipality ceased in 1881 and was left to the proper officers of Government (G.O., No. 234 W., dated 28th January 1881).

No. 2704, Financial.

Transferred to the Public Works Department.

(By Order.)

Fort St. George,
5th December 1884. (Signed) J. D. REES,
Ag. Under Secy. to Govt.

No. 2612, Marine.

Transferred to the Public Works Department.

22nd November 1884. (Signed) E. F. WEBSTER,
Chief Secretary.

From R. B. BUCKLEY, Esq., Officiating Under Secretary to the Government of India, Public Works Department (Civil Works—Miscellaneous), to the Secretary to the Government of Madras, Public Works Department, dated Fort William, 28th November 1884, No. 450 M.

In compliance with the request contained in your letter, No. 2815 W., dated 10th November 1884, I am directed to forward the accompanying copy of a despatch to the Secretary of State, No. 32 P.W., dated 4th July 1884, regarding the restoration of the Madras Harbour.

Enclosure.

Despatch from the Government of India, Public Works Department (Civil Works—Miscellaneous), to the Right Honorable Her Majesty's Secretary of State for India, dated Simla, 4th July 1884, No. 32 Public Works.

In continuation of our despatch, No. 59 P.W., dated 13th November 1883, and with reference to your Lordship's despatches, Nos. 23 and 28 P.W., dated 24th April and 15th May 1884, respectively, in connection with the Madras Harbour Works, we have the honor to forward,

for the information of Her Majesty's Government, copy of a further communication from the Government of Madras, and to state that we concur generally in the opinions therein expressed concerning the restoration of the harbour.

G.O., dated 6th December 1884, No. 6093, Military.

From the Controller of Military Accounts, to the Secretary to Government, Military Department, dated Fort St. George, 1st December 1884, A.

In forwarding the accompanying letter * from the Commissary-General, I have the honor to express my concurrence with the views held by him, and to attach a letter † from the Examiner of Public Works Accounts, to whose department the charge appertains.

* No. 2124 T.B., of 22nd November 1884, stating that the Harbour authorities have no claim to rent for mule lines if it is not within their limits.
† No. 57 C.M.A., of 28th November 1884.

ENCLOSURES.

From the Commissary-General, to the Secretary to Government, Military Department, dated Madras, 22nd November 1884, No. 2124 T.B.

I have the honor to acknowledge the receipt of Proceedings of Government in the Public Works Department, No. 2817 W., of the 10th instant, forwarded for report under your docket, No. 5627, of the 13th idem, and herewith returned as requested.

2. Mr. Parkes, Chief Engineer of the Madras Harbour Works, in paragraph 57 of his report claims rent for the site on which the commissariat mule stables now stand on the plea that five years ago this site was in the surf and that the beach on which the stables stand has been reclaimed in consequence of the construction of the harbour works.

3. It seems open to question whether the reclaiming of this beach was a portion of the original harbour scheme, or whether this steady encroachment of the sand is not a danger which gives the authorities considerable anxiety for the future of the harbour.

4. If this reclamation was not a portion of the original scheme, it appears doubtful whether the harbour authorities can claim rent for a site which they had no direct intention of forming.

5. A question of fact also arises, viz., whether the site of the commissariat mule lines was five years ago in the surf as stated by Mr. Parkes. That officer may not be aware that to prevent the encroachment of the sea a number of stone groynes were many years ago thrown out by the Engineer Department of Government, the first being constructed opposite the office of Messrs. Parry and Company as far back as 1853.

6. These groynes reclaimed a considerable beach, and in default of accurate measurements of the foreshore for many years past I think some further proof is needed of Mr. Parkes' statement that the site on which the mule stables stand has been reclaimed since the harbour works commenced.

7. Moreover if, as I suppose, the commissariat mule sheds are beyond harbour limits the harbour authorities can, I imagine, have no claim to rent.

From the Examiner, Public Works Accounts, to the Controller of Military Accounts, Fort St. George, dated Madras, 28th November 1884, No. 57 C.M.A.

In returning the papers received with your memorandum, No. 2644, dated 25th November 1884, I have the honor to state that this office has no remarks to offer on the question raised.

Order—dated 6th December 1884, No. 6093, Military.

The replies of the Commissary-General and Controller of Military Accounts communicated to the Public Works Department.

(True Extract.)

(Signed) A. KENNEY-HERBERT, Lt.-Col.,
Offg. Secy. to Govt., Mily. Dept.

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From F. N. THOROWGOOD, Esq., M. INST. C.E., Superintendent, Madras Harbour Works, to the Secretary to Government, Public Works Department, dated Madras, 6th December 1884, No. 27 W.

I have the honor to acknowledge the receipt of your memorandum, No. 1996 C., of the 4th, asking my opinion as to the sufficiency of the estimates made by Mr. Parkes for the restoration of the Madras Harbour and forwarded with the Secretary of State's despatch, No. 56, of September 25, 1884.

2. I have carefully examined all the details of the estimates, and indeed was in consultation with Mr. Parkes at Westminster when they were made, and I believe that they are perfectly sufficient for the work to be done.

3. I beg to be permitted to add that I hope the arrangement suggested in paragraph 37 of Mr. Parkes' report may be carried out, substituting for the date April 30, 1884, the date at which the *bonâ fide* work of restoration on the new design shall commence, and correcting the figures accordingly. An infinite deal of trouble and numerous petty disputes will be avoided if we can start fair on a new estimate, the detailed arrangements of which can be made between the Examiner of Public Works Accounts and myself.

4. I return the papers marginally noted, as I imagine you intend that I should do.

1 Despatch.
2 Plans.

ORDER—dated 19th December 1884, No. 3127 W., Public Works.

In his despatch of the 25th September 1884, No. 56 P.W., the Secretary of State communicates to the Government of India the conclusions at which he has arrived in respect to the restoration of the Madras Harbour Works. It is intimated that the plan of future operations proposed by Mr. Parkes should be followed generally; the eastern entrance being maintained, in the absence of any additional facts or arguments of sufficient weight to justify a further reference to engineering authority in England. The revised estimates framed by Mr. Parkes should, it is stated, be examined and reported on.

2. His Excellency the Governor in Council observes that a decision having been come to in favor of the eastern entrance, there seems nothing to prevent the immediate prosecution of the work of restoration on the estimates framed by Mr. Parkes, the sufficiency of which for the object in view there seems no reason to doubt.

3. The Examiner, Public Works Accounts, reports that he sees no objection to the proposed recasting of the heads of account under which the expenditure on the works has been recorded. The details of the re-arrangement can now be undertaken on the lines suggested by the Superintendent in his letter, No. 27 W., dated 6th December 1884.

4. It is observed that the accretion to the south of the harbour is vested in the Marine Department under the provisions of the Indian Ports Act XII of 1875, and that the rents collected for occupation of the land are carried to the credit of the harbour dues account, to assist in meeting the interest on the capital cost of the harbour works.

5. A copy of these Proceedings will be forwarded to the Government of India in reply to their endorsement, No. 415 M., dated 28th October 1884.

(Here enter No. 3128 W., dated 19th December 1884.)

(True Extract.)

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

To the Superintendent, Madras Harbour Works.
" Examiner, Public Works Accounts.
" Marine Department.
Exd. C. Howarth.
Spare Copies

BUILDINGS AND ROADS.
CIVIL WORKS.

Govt. of {1884} Madras.

PUBLIC WORKS.

Dated December, 19th.

Recd. *Encl.*

G.O., 19th Dec. 1884, No. 3127 W.

DECEMBER.

Madras Harbour Works

Orders on the subject of the reconstruction of the —.

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GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

Buildings and Roads.
Civil Works.

READ—the following letter from F. N. THOROWGOOD, Esq., M. INST., C.E., Superintendent, Madras Harbour Works, to the Secretary to Government, Public Works Department, dated Madras, 3rd December 1885, No. 44 W.:—

I have the honor to report the progress on these works during the past month of November. It will be borne in mind that from the latter part of October until the end of December work in the sea is very uncertain, and all out-door work is liable to sudden stoppage by rain.

2. *North pier rubble base.*—Work was very much interrupted during November by the sea being just too rough for working the boats. From the 13th to the 19th the sea was at times high and broke very heavily through the ruins of the outer portion of the north pier, overturning the beacons which mark the new centre line. During the month we only succeeded in depositing 6,322 tons of rubble base, or nearly 2,000 tons less than in October, but there has not yet been a satisfactory month's work done in November and it is advisable to adopt a cautious policy.

3. *South pier rubble base.*—At the south pier, the state of the sea has put a stop to all work, both of depositing rubble and blasting away submerged block. The diving boats have been hauled up for cleaning and repair.

4. *Block-making.*—The manufacture of concrete blocks for the new section of piers was carried on throughout the month except when stopped by the heavy rain which fell after the 12th November. A total of 171 concrete blocks were made in November, representing about 2,736 tons of concrete. There are now 980 blocks ready for the new section of work, and they will be most thoroughly indurated by the time they are required, which I hope and expect will be next month.

5. The cement used for block-making during November was entirely of English manufacture, the local factory not then having any which met with my approval.

6. *Pallávaram quarries.*—The rain did much damage at the Pallávaram quarry lines, and for four days the traffic up to the end of the quarry had to be stopped. Only 8,968 tons were supplied during November, as compared with 12,553 tons quarried in October.

7. Trains had frequently to be cancelled by telegraphic orders from this office, and the stone traffic was entirely and unavoidably at the mercy of the weather. I should like to record that the traffic department of the South Indian Railway carried out all the many and sudden changes in the running of trains most courteously and satisfactorily.

8. The outturn of stone from the quarries is now increased (weather permitting) from 576 tons to 840 tons a-day. This is owing to the increased power of the locomotive engines now used, which draw a train of 35 wagons instead of 24 wagons. With three more trains running daily, the supply will be sufficient to keep work going at full speed.

9. The police guard (see G.O., No. 2144 W., 14th September 1885, paragraph 2 of report) attached to the quarry under the contractor's arrangement is undoubtedly of great use. Defaulting coolies have been caught and brought back to work by the constables from places as far away as Nellore.

10. *Cranes and plant.*—I reported last month that the north pier Titan was ready for work on 31st October. I have also reported separately (letter, No. 38 W., dated 4th November, and G.O., No. 2643 W., dated 7th November 1885) that on 4th November the Titan was capsized through the rash treatment of Mr. G. Gunther, Foreman Engineer, who had done himself infinite credit by the way in which he had worked at erecting the crane. It was placed back in its proper position and repaired by the 9th November, no serious damage having occurred either to crane or to workpeople. The rain and rough sea since delayed my ordering the Titan be advanced out, but on the 30th November it was travelled along its rails for a distance of 400 feet and is now standing on the north breakwater waiting for an opportunity to deposit blocks in the "wave-breaker." It is not my intention to travel it out to the end of the breakwater for setting the blocks in the new pier till January, as the weather is never to be trusted till about the middle of that month.

11. Three days were spent, after the most unfortunate upset of 4th November, in thoroughly testing the stability of this crane, as the upset had caused something like a panic amongst those who were working at the time. These experiments of testing proved most satisfactory as a load of 31 tons was run out 2 feet further than will ever be required, and not the slightest suspicion of tilting up apppeared.

12. I have since had a very close investigation into the accident of 4th November, and I can blame no one but Mr. G. Gunther, to whom I have given in writing a most severe and serious reprimand, reviewing the whole position from beginning to end. In my own opinion this, to a man of great ability and of most excellent character, is punishment enough, especially as it clearly points out that it is only his previous and present character and energy which saves him from more severe treatment.

13. The Titan crane for the south pier is approaching completion. I withdrew all hands from other work to the north Titan from 4th November to 10th, so some delay has occurred in consequence.

14. The wave-breaker crane is progressing slowly. It is a gigantic machine to erect, the two main girders being each 107 feet long, and its weight without any load being 137 tons. I think it will be ready for work by the time it is wanted, which will be when the Titan is setting the blocks in the new section of pier.

15. *Stores.*—No stores from England have been received in November.

ORDER—dated 7th December 1885, No. 2922 W., Public Works.

Recorded.

2. Paragraphs 7 and 8 will be communicated to the Consulting Engineer for Railways.

3. In G.O., No. 2741 W., dated 16th November 1885, the Government expressed their pleasure at the result of the endeavours made to re-establish the Titan crane in its proper position; and they now learn with satisfaction that it has successfully stood the various experimental tests made to determine its stability. It is observed that Mr. Gunther, to whose want of judgment the accident to the crane was solely due, has been severely reprimanded.

(True Extract.)

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

To the Superintendent, Madras Harbour Works.
" Consulting Engineer for Railways.
" Marine Department.

Exd. E Fernandez.
Spare Copies

BUILDINGS AND ROADS.
CIVIL WORKS.

Govt. of {1885} Madras.

PUBLIC WORKS.

Dated December, 7th.

Read. *Encl.*

G.O., 7th Dec. 1885, No. 2922 W.

DECEMBER.

Madras Harbour Works

Orders on the progress report of the —, for the month of November 1885.

GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

Buildings and Roads.
Civil Works.

READ—the following letter from F. N. THOROWGOOD, Esq., M. INST., C.E., Superintendent, Madras Harbour Works, to the Secretary to Government, Public Works Department, dated Madras, 5th January 1886, No. 49 M.:—

I have the honor to submit the following report of the progress on these works for the past month of December, during which the weather was most unfavorable for marine operations of all kinds; at the same time, I give a brief summary of work done in 1885.

2. *North pier superstructure.*—Whenever the sea permitted, masons and platelayers were employed at removing the existing rails on the north pier and building in the lines for the Titan and wave-breaker cranes, as well as for the narrow and broad gauge trucks. This essential change in the arrangement of the lines I have deferred to carry out as long as possible as it interferes seriously with the South Indian Railway stone traffic; it must, however, be done now, and all possible pressure has been put on during December, the breaking waves have nevertheless hindered work seriously. The rails have to be built in firmly with Portland cement, and the outer pairs form the permanent roads for advancing and retiring the cranes while work goes on. A length of 936 feet of this permanent road is now complete. Until the whole length of 2,200 is finished, nothing more can be done to the superstructure, as the next operation is to travel out the Titan to the extreme end of the pier to commence regular work. A few days of smooth weather will suffice to finish this work; but while (as now) the sea splashes over the blocks, it is not possible to bed the rails securely.

3. *North pier foreshore and rubble base.*—Unfavorable weather, both in the way of rain and of sea, delayed the work of quarrying stone and of depositing rubble base, and latterly the alterations in the railway lines above referred to have added a third cause of delay. Only 209 tons of stone were deposited in the north pier base in December.

In Mr. Parkes' report of 21st August 1884, paragraphs 8 and 9 (G.O., of 19th December 1884, No. 3127 W.), he refers to forming a nucleus of large rubble stone for the interior of the wave-breaker. The work of forming this nucleus I have now taken in hand, and up to the end of December this was completed to a distance of 575 feet from the commencement of the north pier. This mound of large rubble has to be covered with 30-ton blocks to form the "wave-breaker," and on the 15th December the Titan crane was advanced to commence depositing these blocks. The weather was not favorable, and at present only 15 blocks have been dropped overboard; but small as this number appears, it marks an epoch in the history of the harbour as till now no block has been set since October 1881. The Titan did its work very well, and it is evident that it is capable of disposing of a great many blocks daily.

4. But this work of depositing the wave-breaker blocks will now (with one exception) be left to the gigantic wave-breaker crane under construction, and the Titan will shortly be working at constructing the new breakwater. The exception referred to will, I trust, be described as complete in the next report.

5. I should report that the "surf bank" or root of the north pier required making up on its exposed side, and that 356 tons of stone were used for this purpose in December.

6. *South pier works.*—At the south pier the work has been confined to throwing up a temporary road on which to advance the new Titan crane; to altering the existing block-yard, and to building in the new lines on the pier for the new system of work, as at the north pier. For the temporary road on which the Titan will advance 1,070 tons of roughstone and débris were thrown down, and on the pier a length of 645 feet of the new arrangement of lines was securely built in. Work at this pier is not interrupted by the sea, so the roads will very soon be properly laid down.

7. *Blockmaking.*—The blockmaking yard was entirely filled during December, only 28 blocks having been made. There is every probability of our being able to get rid of a good number during the current month, and then blockmaking can go steadily on. There are now on hand 800 blocks for the old design, all of which will be used up in the wave-breakers, besides 1,008 blocks for the new section, giving a total of 1,808 blocks ready for use at date.

8. *Pallávaram quarries.*—During December only 6,153 tons of stone were received from Pallávaram. The railway lines are being extended at the quarries and more siding accommodation will be provided, a point that the South Indian Railway Company have drawn attention to as facilitating the working of the stone trains.

9. *Cranes and plant.*—The north pier Titan I have already reported as being in actual work. The south pier one is very nearly completed, and will shortly be tested for stability. The gigantic wave-breaker crane is getting on well at the north pier, but its erection forms a considerable engineering work by itself. The main girders are now in position. As this is a crane without a duplicate in the world, I have taken the liberty to submit, herewith, a photo-lithograph of its outline and general shape. The balance of it, under some conditions that will occur in practice, is very delicate, and a thorough knowledge of the varying positions of the centre of gravity is essential. Mr. Parkes, in connection with the builders, Messrs. Ransomes and Rapier, has furnished me with every possible detail and calculation, and these it will be the Superintendent's duty to transfer into some practical rules for the guidance of the men working the crane. With this machine a load of 40 tons can be dropped into the sea at a point overhanging the rail on which the nearest line of wheels travels by a length of 40 feet.

10. *Inspection of works.*—On 23rd December the works were visited by Brigadier-General Annesley, Adjutant-General of the Bombay Army, accompanied by Lieutenant-Colonel Mackinnon. They witnessed, under rather trying circumstances, the operation of dropping a 30-ton block into the sea to form the wave-breaker. And on the 28th, His Excellency Lord Reay, Governor of Bombay, accompanied by Major G. Moore, R.A., closely inspected the whole work at both piers and in the blockmaking yard.

11. *Expenditure.*—As this new work of restoration has, as yet, no sanctioned form of estimate, I am unable to furnish an intelligible schedule of expenditure as compared with such estimate. I can, however, state that the total expenditure on the works, exclusive of "suspense accounts," between 1st January and 31st December 1885 has been Rs. 5,16,332, of which amount Rs. 56,994 has been expended on "establishment." Between 1st January and 31st December 1884 the expenditure on establishment was Rs. 59,273, so there has been a saving under this head during the past year of Rs. 2,279 over what was expended in twelve months when much less work was going on.

12. *Summary for* 1885.—During 1885 the outturn from Pallávaram quarries was 1,13,172 tons of stone, of which 32,125 tons were deposited in the south pier submerged work and 62,451 tons in the north pier work, the balance being used in blockmaking. There have been 1,008 concrete blocks for the new design made, some from local cement and some from English.

13. The health of the staff has been only pretty good, and of accidents there have been few. On the whole the year's work may, I think, be regarded as satisfactory considering the delay in receiving the all-important cranes and machinery. The death

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of Mr. Beardmore, on 2nd June, was much to be lamented, and his absence on leave and subsequent sickness deprived the works of the benefit of an Assistant Superintendent except for 71 days, from 1st January to 20th August, when Mr. A. L. Pogson assumed that office.

A most respectable and excellent English engine-driver, Mr. P. Pistoll, died early in the year, and in June a useful clerk, Mr. E. D'Vaz, also died.

All three English foremen were likewise laid up during the hot weather. In April Mr. B. C. Dumphy took charge of the post of Sub-Engineer from Mr. Bhemaya Saenna, at a less salary. All important work has been let by contract in reply to call for tenders by advertisement, and I am happy to report that all is at present going on satisfactorily.

Order—dated 18th January 1886, No. 139 W., Public Works.

Recorded.

2. Taking into consideration the unfavorable state of the weather, the report is satisfactory.

(True Extract.)

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

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

Exd. E. Fernandez.
Spare Copies

BUILDINGS AND ROADS.
CIVIL WORKS.

Govt. of {1886} Madras

PUBLIC WORKS.

Dated January, 18*th*.

Read. *Encl.*

G.O., 18th Jan. 1886, No. 139 W.

JANUARY.

Madras Harbour Works

Progress report of — for December 1
recorded.

No. 49 M 18

FROM

THE SUPERINTENDENT,

MADRAS HARBOUR WORKS,

To The Hon^ble Colonel J. A. M. Shaw Stewart, R.E.
Secretary to Government P. W. Department
Fort St. George

MADRAS, 5th January 1886.

Sir,

I have the honour to submit the following report of the progress on these works for the past month of December, during which the weather was most unfavourable for marine operations of all kinds; at the same time I give a brief summary of work done in 1885.

North Pier Superstructure

2. Whenever the sea permitted, masons and quarrymen were employed at removing the existing parapets on the North Pier and building in the lines for the Titan and Wave breaker cranes, as well as for the narrow and broad gauge tracks. The essential change in the arrangement of the lines I have described to carry out as long as possible as it interferes seriously with the South Indian Railway steam traffic; it must however be done now, and all possible pressure has been put on during December, the breaking waves have nevertheless hindered work seriously. The parapets have to be built in firmly with Portland cement, and the outer pairs from the permanent roads for advancing and retiring the cranes while work goes on. Although

of 936 feet of this permanent road is now complete. Until the whole length of 2200 is finished nothing more can be done to the Superstructure, as the next operation is to travel out the Titan to the extreme end of the pier to commence regular work. A few days of smooth weather will suffice to finish this work, but while (as now) the sea splashes over the blocks it is not possible to bed the rails securely.

North Pier Jetty and Rubble Bay

3. Unfavourable weather both in the way of rain and of sea, delayed the work of quarrying stone and of depositing rubble base, and latterly the alterations in the railway lines above referred to have added a third cause of delay. Only 209 tons of stone were deposited in the North Pier in December.

Mr Parkes' report of August 21st 1884 paras 8 and 9 (C) of December 9th 1884 No 3127 (C) he refers to forming a nucleus of large rubble stone for the interior of the wave breaker. The work of forming this nucleus I have now taken in hand and up to the end of December this was completed to a distance of 575 feet from the commencement of the North Pier. This mound of large rubble has to be covered with 30 ton blocks to form the "Wave breaker" and on the 16th December the Titan crane was advanced to commence depositing these blocks. The weather was not favourable, and at present only 15 blocks have been dropped overboard, but small as this number appears it marks an epoch in the history of the Harbour as till now no block has been set since

October

October 1881. The Titan did its work very well, and it is evident that it is capable of disposing of a great many blocks daily.

4. But this work of depositing the wave breaker blocks will now (with one exception) be left to the gigantic Wave breaker Crane (under construction, and the Titan will shortly) be working at constructing the new breakwater. The exception referred to will I trust be described as complete in the next report.

5. I should report that the Turf Bank or root of the North Pier required making up on its exposed side and that 356 tons of stone were used for this purpose in December.

South Pier Extn.

6. At the South Pier the work has been confined to throwing up a temporary road on which to advance the new Titan Crane, to altering the existing block yard and to building in the new lines on the pier for the new system of work, as at the North Pier. For the temporary road on which the Titan will advance 1070 tons of rough stone and debris were thrown down, and on the pier a length of 645 feet of the new arrangement of lines was recently built in. Work at this pier is not interrupted by the sea, so the roads will very soon be properly laid down.

Block making.

7. The block making yard was entirely filled during December, only 28 blocks having been made. There is every probability of one being able to get a good number during the current months,

and

and then blockmaking can go steadily on. There are now on hand 800 blocks for the old design all of which will be used up in the wave breakers, besides 1008 blocks for the new section, giving a total of 1808 blocks ready for use at date.

Pallaveram Quarries

9. During December only 6153 tons of stone were received from Pallaveram. The railway lines are being extended at the quarries and more siding accomodation will be provided, a point that the South Indian Railway Company have drawn attention to as facilitating the working of the stone trains.

Cranes & Plant

10. The North Pier Titan I have already reported as being in actual work. The South Pier one is very nearly completed and will shortly be tested for stability. The gigantic Wave breaker crane is getting on well at the North Pier, but its erection forms a considerable engineering work by itself. The main girders are now in position. As this is a crane without a duplicate in the world I have taken the liberty to submit herewith a photo-litho-graph of its outline and general shape. The balance of it, under some conditions that will occur in practice, is very delicate and a thorough knowledge of the varying positions of the centre of gravity is essential. Mr Parkes in connection with the builders. Messrs Ransomes and Rapier, has furnished me with every possible detail and calculation, and these it will be the Superintendent's duty to transfer into some practical rules for the guidance of the men working the crane. With this machine a load of 40 tons can be dropped into the sea at a point overhanging the rail on which the nearest line of wheels travels by a length of 40 feet.

Inspection of Works.

11. On December 23rd the works were visited by Brigadier General Annesley, Adjutant General of the Bombay Army accompanied by Lieutenant Colonel Mackinnon. They witnessed under rather trying circumstances the operation of dropping a 30 ton block into the sea to form the wave breaker. And on the 28th His Excellency Lord Reay, Governor of Bombay, accompanied by Major G. Moore, R.A. closely inspected the whole work at both piers and in the blockmaking yard.

Expenditure

12. As this new work of restoration has, as yet, no sanctioned form of Estimate, I am unable to furnish an intelligible schedule of expenditure as compared with such estimate. I can however state that the total expenditure on the works, exclusive of "Suspense Accounts" between January 1st and December 31st 1885, has been Rs. 5,16,332 of which amount Rs. 56,994 has been expended on "Establish-ment". Between January 1st and December 31st 1884 the expenditure on Establishment was Rs. 59,273, so there has been a saving under this head during the past year of Rs. 2279 over what was expended in 12 months when much less work was going on.

12

12. During 1885 the net turn from Pallaveram Quarries was 113,172 tons of stone, of which 32,126 tons were deposited in the South Pier submerged work and 62,451 tons in the North Pier work, the balance being used in block making. There have been 1008 concrete blocks for the new design made, some from local cement and some from English.

Summary for 1885.

13. The health of the staff has been only pretty good, and of accidents there have been few. On the whole the years work may I think be regarded as satisfactory considering the delay in receiving the all important cranes and machinery. The death of Mr Beardmore on June 2nd was much to be lamented, and his absence on leave and subsequent sickness deprived the works of the benefit of an Assistant Superintendent except for 71 days, from January 1st to August 20th, when Mr A. L. Pogose assumed that office.

A most respectable and excellent English engine driver Mr T. Pistoll died early in the year, and in June a useful clerk Mr E. D'Vaz also died.

All three English foremen were likewise laid up during the hot weather. In April Mr B. C Dunphy took charge of the post of Sub. Engineer from Mr Bhimaya Sanna, at a less salary. All important work has been let by contract in reply to call for tenders by advertisement, and I am happy to report that all is at present going

going on satisfactorily.—

I have the honour to be,
Sir
Your most obedient Servant
F. N. Havelock, M. Inst. C.E.
Superintendent.

21

Encl 86

No 139 W dy 18 January 86.

A

Recorded

2. Taking into consideration the unfavourable state of the weather the report is not unsatisfactory.

7/1/86

Buildings & Roads

From

The Superintendent
Madras Harbour Works

No 149 W
Dated 5th January 1886.

No of Enclosures One

To,

The Supdt M.H. Works
" Marine Supdt

Dated 28/1/86

Progress Report

Submits ——— for December 1885

With order

Cert. 7.1.86.

7.1.86

G.O. 3129 W dy 19.12.84
" 2922 W dy 7.12.85

97

86

Govt. of Madras. 1886

PUBLIC WORKS.

Dated

Rcvd.

Encl.

G.O., No. 1886, No. 136

Progress Report

60

3

No. 5100.

From

The SUPERINTENDENT,

MADRAS HARBOUR WORKS,

To The Hon'ble Colonel J. H. M. Shaw Stewart, R.E.
Secretary to Government,
Public Works Department.

Madras, 3rd February 1886.

Sir,

I have the honour to submit a report of progress on these works during the past month of January, and I must express my regret that although no exertion has been spared on the part of the Harbour Works staff, the end of the month arrived before all operations were in activity. I can safely say however, at this date, that all preliminaries will be completed this week, and the depositing of blocks will be begun.

North Pier Superstructure

2. It was not until the 15th January that the masons and plate layers could get to full work at removing the old rails and re-laying the new roads in cement concrete, as described in para: 2 of my last report. By keeping the men at work overtime, so soon as the sea became smooth, the new lines of rail were completed by the 29th January, the work done being 1303 lineal feet of permanent road for the cranes, 1908 broad line gauge railway and 1702 feet of narrow gauge railway,

railway all this securely bedded into the concrete blocks with Portland cement - A temporary line was also laid down to the extreme end of the standing portion of the pier, 2,750 feet from commencement; from which heavy boulders were thrown into the sea to form the hearting or core of the "wave breaker" - This piece of work at the end of the existing pier has taken 14 days longer to complete than I anticipated, and hence it comes that the Titan crane had not up to January 31st been able to get to work.

North Pier Foreshore & Bn

3— The fine working weather set in about January 15th, and since then the boats have been depositing rubble base and the divers have been busy blowing up concrete blocks which lie in the line of foundation - A total of 2765 tons of material was deposited during January, of which 1539 tons represent pieces of demolished blocks, 57 in number - The blocks were usual broken up with dynamite, fired by electricity - There were 2992 tons of very large boulders thrown over the side of the pier to form the hearting of the wave breaker, and these boulders will now be covered with 30 ton blocks deposited by the Titan crane, preparatory to setting the abutment of the new superstructure

11

South Pier Works 4— At the south Pier, all force had to be put on to re laying the railway lines, as in December there are now 1857 ft of crane roads built in, and 1774 of both broad and narrow gauge road. On the 18th January the South Pier Titan Crane, having been thoroughly tested, was advanced forward on to the South Pier very satisfactorily, a distance of about 1300 feet - I hope to get this crane to work this month, but much will depend upon the rapidity with which we can form the protecting wave breaker at the present end of the North Pier, as part of the gearing for disengaging the 30 ton blocks can only be used on one crane at a time. The inconvenience of this will only be felt at first.

5— At the rubble base of the South Pier the divers have been blowing up a few concrete blocks to the extent of 133 tons.

Pallavaram Quarries 6— From Pallavaram quarries the out turn was small during January, as the lines of both piers were impassable during the alterations, and consequently very little rubble stone was required. Only 5948 tons were received - The quarry lines at Pallavaram were thoroughly inspected on January 13th by the Locomotive Superintendent

Superintendent and District Traffic Superintendent of the South Indian Railway, in company with Mr. A.L. Pogson and myself. More siding accommodation is required there, and is now being provided, for which purpose I have had to detail several plate layers from the Harbour Works. At the date of writing, the trains have resumed running to the number of 11 daily, and with the new siding accommodation this will be increased to 6.—

7— As already reported, the South Pier Jetan has been completed, tested, and travelled on. The large and special crane for the Wave Breakers date was completed on the 29th January, and from that, I have been putting it through a series of tests for balance. Its stability appears to be precisely as shewn by calculation. There were and are still some disagreeable hitches in the working of the machine, which have taken up much of the time of the leading members of the staff as well as of myself; but I hope that we shall be able to get all into smooth working order in a day or two.

8— Although I am much disappointed at what I have to report for January, yet I

Cranes & Plant

G.O. 80/139. 13th Feb 86.

Less work done than was hoped for

I must ask that it be borne in mind that only from the 15th was the weather really good, and that the tedious and heavy work of altering all the lines on both piers practically put a stop to other work. These lines are now complete

v of base

9— Another piece of work that has been completed in January, and without which we could do nothing, is the survey of the whole of the rubble bases of the new work by Mr. Pogson, and this could not be attempted until the 18th January. We now are in a position to proceed freely, as I fully hoped we should have been 10 days ago.

I have the honour to be,

Sir,

Your most Obedient Servant,

F.W. Harrowgood M. Inst. C.E.

Superintendent.

Jas

Ref 805 A

Bt Works

Buildings and Roads

From

The Superintendent
Madras Harbour Works

No 398 Wd/Job. 13.2.86
Hon. H. E. Ludlow.

RECEIVED
4 FEB
SECRETARIAT

No. 51 W.

Dated 3rd February 1886.

The Govt. fully recognise the difficulties which have been encountered, and they trust that the record for February will show better progress.

6-2-86

No of Enclosures — Nil.

G.O. 3127 Wd/19.12.84
" 2922 Wd/7.12.85
" 1394 Wd/18.1.86. 085

Supt. Hr. W.
Consg. Engineer
Marine Dept.

18/2

Progress Report

Submits — for January 1886

With order

6.2.86

896

Govt. of Madras.

PUBLIC WORKS.

13/4/86

Dated

Rect.

Encl. 1

G.O., 13 April, 1886, No. 396

Estimate

Copies sent to Municipal Council by Mr Lynch, C.E. Tuticorin for favour of R.

50/14

60/5

12.8.86

Printer