

GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

9th December 1880, No. 2,851 W.

Buildings and Roads.
Civil Works.

Read the following paper :—

No. 41. From F. N. THOROWGOOD, Esq., M. Inst. C.E., Superintendent, Madras Harbour Works, to the Secretary to Government, Public Works Department, dated Madras, 4th December 1880, No. 62 W.

I HAVE the honor to submit the following report of the progress on these works during the past month of November, and I regret to have to state that the advance of the work has been very small, while the casualties have been great.

2. *North Pier Superstructure.*—On the 1st of the month the sea was sufficiently heavy from the north-east to carry away 50 feet of the line of rails on the north pier, and it was not until the 10th that the damage was repaired. There then occurred a few days of fair weather and smooth sea, during which 32 blocks were set, and the pier advanced by a length of 19 lineal feet. The total length of the pier is now $3,606\frac{1}{2}$ feet from the commencement.

3. *Sea Damage.*—During the remainder of November the sea has prevented all work, and between the 19th and 22nd was so heavy as to cause damage to the following extent:—From the middle of the curve outwards nearly the whole of the rails and sleepers were torn off and thrown into the harbour, but these are all recovered again. The portion of the pier that has been constructed since January 1880, and over which no heavy seas had previously broken, settled down evenly to its correct height above mean sea level, as was expected, and the centre joint between the two rows of blocks closed up to such an extent that the blocks ground into one another at their top edges. The result of this has been to break off some of the inner top corners, which gives an unsightly appearance until repaired; but the *general* effect on the work is to consolidate it by closing the joints. At the extreme end of the pier the action of the waves was greatly increased by the local eddy round the corners of the blocks, and this eddy reached down to the rubble base to such an extent as to disturb the stone exactly at the foot of the last row of blocks, especially at the inner corner, where the blocks have settled 36 inches. This action was strictly confined to the last row, no disturbance whatever having taken place in the blocks immediately preceding this row, nor in any other blocks throughout the pier. As I was fully prepared for this action, and had secured the end row by iron clamps, the damage is confined to the excessive settling down almost vertically of the last row of blocks, the clamps (which have not given way in any place) serving to keep any blocks from falling over. This is all the damage that the actual pier has sustained, and it can be put right in six hours. I should remark that I have had the end of the pier thoroughly examined by the Foreman Diver, on whose information I report. Numerous sections are now being taken, the weather being favorable.

4. *North Pier Rubble Base.*—The uncertain weather has naturally interfered with the deposit of rubble base, but I have carried on this branch of the work whenever it was possible. During November 10,919 tons of laterite were deposited, of which the two steamers carried 8,188 tons. It is satisfactory to note that whereas in October and November 1879 these two vessels were idle at Cocanada, they have in the corresponding months of this year deposited over 20,000 tons of material in the rubble bases of the two piers.

5. The North Pier Base is now approaching completion, but each lineal foot of advance requires a great deal more material than formerly. This is partly on

account of the great amount of fine small laterite which it is impossible to avoid bringing with the larger boulders from the quarry, but which makes hardly any increase in the submerged base; and partly because of the thick coating of mud which overlies the hard sand about the 7 and 8 fathom depths of the harbour. This layer of mud was first noticed in 1876 when we were taking observations at the bottom with a diver. It is sufficiently soft to be easily displaced by the super-imposed rubble, which finds its way through to the sand below.

6. *Concrete Blockmaking.*—The heavy and persistent rains in November have interrupted the making of concrete blocks considerably. At the north block ground the machinery was chiefly employed in making special blocks for the pier head. At the south pier block ground I suspended work on the 19th November in order to reduce the expenditure during the current year. The total number of blocks made in November has been 328, but many of these are small ones, of from 7 to 12 tons weight only, for the north pier head.

7. *Quarries.*—The outturn from the quarries has not been large, owing to the heavy rains which prevented all work on several occasions. From Ambatúr 13,065 tons of laterite were received, and from Pallávaram 11,234 tons of hard rock, giving a total for the month of 24,299 tons. During the corresponding month of last year only 16,324 tons of stone were received on the works. From November 23rd to 29th all traffic from the Pallávaram quarries to the beach was suspended for carrying out the raising of the wooden bridge over the canal near the General Hospital.

8. *South Pier Superstructure.*—The progress at the south pier has been better than at the north, but still very small. Between the 6th and the 20th November 64 blocks were set, advancing the pier by a length of $37\frac{1}{2}$ feet, and making the total length from the commencement $3,112\frac{1}{2}$ feet. Since the 20th November no work has been done, and the heavy sea of the 21st has done much damage to the rails, &c., although the pier itself is uninjured.

9. *Sea Damage.*—At the south pier I had not taken the precaution to unfasten the fish-plates of the rails on the outer lengths of the line, as is always done at the north pier in bad weather. My reason for ordering that this should not be done was because I felt confident (wrongly, as it turned out,) that any sea which would attack the south pier would surely come from the north-east, and would therefore strike the work nearly end on. The seas of the 21st came from south-east and east-by-south with great force and striking the outside rails on the newer and more unconsolidated portion of the pier, tore them up from the extreme end to beyond the commencement of the curve (a distance of nearly 900 feet) and as the fish-plates were for the most part bolted fast, the rails were twisted and broken in a way that renders many of them useless. At the extreme end the last row of blocks settled down rather unevenly, but throughout the work the centre joint has closed up tight, and in no spot has the settlement been more than was allowed for in construction. The last row of blocks in the south pier has not been disturbed by the eddy of the waves round the exposed end, as was the case at the north pier. The reason of this is because the foundation course of the next row of blocks in advance was set in position as a protection to the foot of the work against this eddy. I should remark that my orders are that this protective course should always be set in position before the Titan is withdrawn for the night, and that the reason of its absence at the north pier was that the divers were prematurely driven out by the rising sea on the 13th.

10. The south pier Titan had a narrow escape of being displaced, but fortunately the sea retired before the damage to it was serious. It was secured in the usual manner, and was in a good position for safety as regards the angle at which the waves struck it. The two timbers carrying the steel rails on which the Titan stands were tied together by four wrought-iron tie-rods with nuts and washers. The object of these ties is to keep the gauge of the road right. The heavy blows of the sea from the south-east struck the timbers on the outer side of the Titan so heavily that the rail was driven against the flange of one of the wheels, which it broke up. At the same time the inner timber carrying the other rail was so severely attacked, that the nuts and washers of the tie-bolts were drawn into the wood and the gauge of the Titan

thrown out 8 inches too wide. The shock of this movement in so heavy a machine as the Titan, coupled with the settling of the blocks to their permanent level, broke the corners off two blocks immediately under the inner hind wheels, and under these conditions we found the Titan on the 22nd, when it was possible to visit the spot.

11. I wish that the above represented the whole of the mishaps during this storm, but Government is aware that in an attempt to get out to the end of the south pier on the morning of the 21st, seven persons were drowned, including Mr. James Duffy and Mr. H. Patching, two valuable men. The loss of Mr. Duffy is to be particularly deplored, as he was indefatigable in his exertions, and universally esteemed. This accident has been reported on separately, and I only refer to it here as a record in the month's proceedings.

12. *South Pier Rubble Base.*—Very little work was done at the Rubble Base, only 7,175 tons having been deposited in November. The storm of the 21st drove all the cargo boats used on this work ashore, but most of them are not badly injured.

13. *Protective Works to the Beach.*—Since October 31st the sea has ceased to encroach to the north of the harbour, and there has been a perceptible recovery of shore. The revetment extending towards the Police Tannah has been lengthened and made up, for this purpose 1,662 tons of boulders have been used. The groynes are kept up and repaired whenever such a course seems necessary towards retaining the sand which has lately come in from the north. On the 22nd November these protective works were thoroughly inspected by Colonel R. H. Sankey, Chief Engineer, Public Works Department, in company with myself.

14. The only stores received from England during November have been two consignments of Portland cement:—

By the ship *Vimiera*, 1,120 casks.
S.S. *Gannet*, 500 casks.

15. *Expenditure.*—The expenditure on the works has been Rs. 1,29,462 during the past month, and the total amount up to the 30th November has been Rs. 47,75,297.

16. *Plans and Sections.*—I submit herewith a lithographed plan, on a scale of 200 feet to an inch, which shows the changes in the line of high water mark since October. It will be seen that to the north there has been considerable gain of shore, and to the south the accumulation has been cut away. Within the harbour area the effect of the north-easterly waves deflected from the south pier is shown, and the result is a cutting away of the shore between the iron pier and the south pier of the harbour. This action is exactly the reverse of what has been occurring inside the north pier. The two longitudinal sections show the extent of the rubble base of each pier on November 3rd, the earliest date at which accurate soundings could be taken.

17. *Visit of His Grace the Governor.*—On the 23rd November His Grace the Governor visited the works and made special inquiries as to the extent of damage incurred, and asked after the families and relatives of those who lost their lives on the 21st at the south pier.

No. 42. ORDER THEREON, 9th December 1880, No. 2,851 W.

ORDERED to be recorded.

(True Extract.)

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

To the Superintendent, Madras Harbour Works.

„ Secretary, Harbour Works Committee.

„ Marine Department.

Exd. S. T. Austin.

Spare Copies

BUILDINGS AND ROADS.
CIVIL WORKS.

Govt. of (1880) Madras.
PUBLIC WORKS.

To

THE SUPERINTENDENT,
MADRAS HARBOUR WORKS,

&c., &c., &c.

Dated December, 9th.

Issued

Recd.

Encl.

G. O., 9th December 1880, No. 2,851 W.

DECEMBER.

Nos. 41-42.

Madras Harbour Works.—Progress Report
of the — for November 1880, recorded.

GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

11th January 1881, No. 60 W.

Buildings and Roads,
Civil Works.

Read the following paper :—

No. 49. From F. N. THOROWGOOD, Esq., M. INST., C.E., Superintendent, Madras Harbour Works, to the Secretary to Government, Public Works Department, Buildings and Roads, dated Madras, 5th January 1881, No. 75 W.

I HAVE the honor to submit the following report of the progress on these works during December 1880, together with a brief summary of the work done in the past year.

2. *North Pier Superstructure.*—No advance whatever has been made at the north pier during December, as every available day has been utilised for relaying the rails and sleepers which were washed off in November. By the end of the month the repairs to the road were completed and work is now resumed at full speed.

3. Careful observations taken since the storms of November show that the settlement of the outer end of the pier is no more than was expected to take place, the level of the top of the blocks being in no case lower than the original design. The rubble base on the outer side of the pier has subsided slightly and evenly, but on the inner side there is no appreciable change.

4. *North Pier Rubble Base.*—The weather has interfered a great deal with the deposit of rubble base, but more work was done than in November. There were 12,372 tons deposited, of which 8,245 tons were carried by the two steam hoppers. The whole of this is for the foundation of the extreme end of the pier which is of great width, and consequently takes more material for each foot of advance than formerly. The base of the north pier ought to be completed during the current month.

5. *Concrete Block-making.*—Block-making in the yard was of necessity suspended for the latter half of the month of December, as there was no room to stack any more blocks, and the state of the sea and absence of rails on the piers prevented the removal of blocks from yard to sea. There were 202 blocks made up to the 13th of December and the greater number of these are for the north pier head. With the exception of a portion of the head, on which I am awaiting Mr. Parkes's decision on the spot, all the blocks for the north pier should be completed in five weeks from this date.

6. *Quarries.*—The outturn from the quarries has not been very large during December for various reasons. From Ambatūr, on the Madras Railway, there were 12,368 tons of laterite received, and from Pallāvaram, on the South Indian Railway, 12,399 tons of granite, giving a total for the month of 24,767 tons. In the month of December 1879 only 18,368 tons of stone were received on the works.

7. *South Pier Superstructure.*—At the south pier work was resumed on the 20th December, but was interrupted greatly by the sea before the end of the month. There were, however, forty-eight blocks set after the 20th, advancing the pier by a length of 28 feet, and making the total length from the commencement 3,139½ feet. Since January 3rd the weather has been more favorable for work and the pier is advancing rapidly.

8. *South Pier Rubble Base.*—A very small amount of work was accomplished at the south pier base in December on account of bad weather, which rendered the cargo boats unmanageable. There were 8,785 tons of stone deposited, of which the two steamers only conveyed 188 tons.

9. *Protective Works north of Harbour.*—The revetment for protecting the coast to the north has been completed as far as the Police Tannah, and it is now being extended further northward. During December 424 tons of large boulders were deposited in this work. The work at present in hand is hardly sufficiently advanced to need reference to the Harbour Committee, as directed in the Order of Government, No. 2,823 W. of December 7th, but I hope shortly to be able to put on more pressure. On this subject I shall be glad to learn Mr. Parkes's wishes, it being a point that he has particularly investigated, and as he will arrive here on January 6th no delay will ensue by awaiting his suggestions.

10. *Stores received on Works.*—During December the following stores were received from England:—

by ship *Red Tauntlet*, 2,134 casks Cement.

S.S. *Poonah*, with diving dresses and apparatus.

11. *Expenditure.*—The expenditure up to the end of December 1880 has been Rs. 48,40,550 subject to some corrections and adjustments in detail.

12. *Plans and Sections.*—The usual lithographed plan and one section are submitted herewith, and I regret that I have not been able to get any soundings on the bases since December 4th, and I am therefore unable to show the precise extent of the rubble foundations. The high water line for December 31st is shown in a line of black cross dots, that of the previous month being in plain dots.

13. *General Summary for 1880.*—The advance of the two piers in 1880 has been much greater than in any previous year, but has not come up to the rate which I hoped to achieve when the year began.

14. The north pier has been advanced by a length of 1,235 lineal feet, and the south pier by 1,420 lineal feet, giving a total for both piers of 2,655 feet in twelve months. Both the piers now terminate in $7\frac{1}{2}$ fathoms water.

15. There have been 381,790 tons of stone sent down to the works in the year, and 291,878 tons have been deposited in the rubble bases.

16. The number of concrete blocks made has been 4,934, and the number set in the piers has been 4,616.

17. The year 1881 commences with everything in readiness for a rapid advance to completion, as the yards are full of well seasoned blocks; there is abundance of good cement and new diving dresses and apparatus have just arrived. The locomotive engines, steam cranes, hopper barges, and all the rest of the plant are in good order, and I trust that in April 1881 the north pier will be finished.

No. 50.

ORDER THEREON, 11th January 1881, No. 60 W.

ORDERED to be recorded.

(True Extract).

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

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

Exd. S. T. Austin.

Spare Copies

BUILDINGS AND ROADS.
CIVIL WORKS.

Gobt. of (1881) Madras.
PUBLIC WORKS.

To

THE SUPERINTENDENT, MADRAS
HARBOUR WORKS,
&c. &c., &c.

Dated January, 11th.

Issued

Recd.

Encl.

G. O., 11th January 1881, No. 60 W.

JANUARY.

Nos. 49-50.

Madras Harbour Works.—Progress Re-
port of the — for December 1880, recorded.

GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

23rd November 1881, No. 2927 W.

Buildings and Roads.
Civil Works.

Read the following paper :—

No. 105. From F. N. THOROWGOOD, Esq., M. INST. C.E., Superintendent,
Madras Harbour Works, to the Secretary to Government, Public Works
Department, dated Madras, 21st November 1881, No. 65 W.

I HAVE the honor to submit as detailed a report as I am able of the damage
Three accompaniments (photographs). sustained by these works on 12th Novem-
ber. The destruction of the two piers
is, however, so very extensive that, even at this date and without having lost any time,
my information is somewhat meagre.

2. PRECAUTIONS FOR BAD WEATHER.—On the afternoon of the 11th November I
received a private note from Captain Taylor warning me that the weather was suspici-
ous; but, as I had taken all the precautions that were in my power to protect the works
and the plant, I could do nothing more when this warning was received.

The two Titan cranes were withdrawn as far from the ends of the piers as I
considered safe, and my reasons for leaving them where they stood instead of taking
them quite back were these :—

I. On two occasions at the north pier, and on one occasion at the south pier,
the work has been rather badly damaged nearer shore than where the Titans
stood on these occasions to which I refer; and I have from long observa-
tion come to the conclusion that a position a short distance back from the
end has hitherto been better than one nearer shore.

II. The position I selected as storm quarters for the Titans this season was
where the blocks are more deeply founded than anywhere in their rear, and
therefore less likely to be undermined. Moreover the surface of the piers
was for 35 to 45 feet wide at these places, and consequently there was a
good margin of block work on each side of each Titan (the span of which
is 20 feet only); I therefore judged that, as in November 1879 and 1880
these machines had stood well in heavy seas on a narrower pier and
shallower foundation, I was not incurring any unwise risk in firmly
securing them at the commencement of the pier heads. And in this
position they were made fast in every way possible.

3. POSITION OF THE "HOBART" AND "SALISBURY."—Similarly with the steamers
Hobart and *Salisbury*, I had moved them from the south to the north of the harbour,
and they were moored by three anchors and a stern fast in absolutely the best berth in
the whole harbour during a north-east sea.

4. THE STORM.—The sea rose in the night of the 11th and by 9 A.M. of the
12th was running very high, and making a clean sweep of the north pier and the
Titan at the end. It was also attacking the outer portion from the curve of the south
pier with great violence. The wind was not high, nor was there very much white
water out to sea, but the waves were very much heavier than any I have seen here

before. At times a sea would strike nearly the whole length of the outer portion of the north pier at the same moment, then shoot up in the air and fall in a powerful cascade over the inner row of blocks. This is noteworthy, as will be seen when I describe the nature of the damage.

5. FORCE OF THE WAVES.—With regard to the force or height of the waves I have no good record. I have seen much heavier seas in the German Ocean, but I have not seen any equal to it during my five and a quarter years experience of Madras. I may mention that Mr. R. F. Chisholm, whose judgment in such a matter must be admitted to be very sound, informs me that he considered the seas of 12th November were much higher than those which accompanied the storm of 1872. I think this should be taken much into consideration, as there is a prevailing impression that, because there was not much wind, there could not be a very heavy sea.

6. LOSS OF THE TITAN CRANES.—At about 10 A.M. on the 12th the south Titan went over into the harbour suddenly, and much of the outer portion of the block work was destroyed. At 12 noon the north Titan subsided gently down behind, paused a little, and then was likewise overturned on its side. There it lay for some hours. The north pier was seen to be badly breached also, but the sea was now so very violent that nothing could be made out with certainty.

7. LOSS OF THE STEAMERS.—The steamers *Hobart* and *Salisbury* were all this time lying quietly at their moorings, and Mr. Boteler, the Mooring Foreman, who had gone on board in the morning remained there all day. As the vessels were lying quite steady, and no message was sent ashore from them hinting that they were not holding well I had no anxiety about them. At about 4 P.M., however, the hawser which answered as a stern fast broke, and almost at the same time the wind got more easterly. Shortly afterwards the fastenings which connected the two vessels gave way and they parted company and were then in danger of sinking. But now it was found impossible to get a boat or catamaran out, and the distance (300 yards) was too great for the rocket apparatus to be used, and hence ensued the lamentable loss of life by the foundering of the vessels already reported. Mr. Boteler, who went on board that morning, by a miraculous escape got ashore with a life buoy after being for a long time in the surf. Six of the crew were also saved by their own endeavours and exertions.

8. DAMAGE TO NORTH PIER.—I will now proceed to describe the damage sustained by the two piers commencing with the north. The bank of laterite rubble at the commencement of the pier known as the "surf-bank," which was completed in October 1876, is much knocked about by the waves on the north side, and a clean breach through was made just in the rear of the first concrete block, set in December 1876. Measuring from this point, the first 400 feet of pier is hardly affected at all. Beyond this distance the rails and sleepers have been torn off, and there are signs of the centre joint of the blocks having slightly opened for a length of 2,050 from the commencement. From 2,050 to 2,240 the centre joint has opened 5 or 6 inches, the opening being caused by the north row of blocks moving outwards. Never before has this result appeared with work founded at a depth of 19 feet below low water, but we have on other occasions invariably noticed that the result of a heavy sea has been to close the centre joint, even to grinding together of the blocks. On examining the rubble base on the outside of the wall along this part (2,100 to 2,300 about), I find that it has been scoured away for a depth of 5 and 6 feet, slightly undermining the blocks. The surface of the rubble is left now at a depth of 22 feet below low water. It formerly was heaped up well over the bottom course, but now the under side of that course is exposed. The slope of the base has been flattened, and what is swept from the top has been drawn out over the toe of the slope.

9. At a distance of 2,240 feet the ruin commences. There now follows nearly 100 feet of pier in which the outer or north row of blocks has been swept away, having fallen in the direction of the waves that struck it; the inner or south row of blocks however remain stationary up to 2,340 feet. From 2,400 to 2,800, all of which is on the curve, the destruction has been very severe, and for 100 feet in this length the blocks are moved to the very bottom, the blocks in the lowest course being in some places broken, and the upper blocks have fallen outward in such confusion

as to render it difficult to identify them. Some have fallen over the edge of the rubble bank. At places here we find the rubble lowered as much as 7 feet, and the blocks undermined, fallen over and broken.

10. From 2,800 outward (the curve terminates at 2,937 feet) for 200 feet the bottom blocks remain sound, but are slightly undermined on the north side, the rubble base having been scoured away for a width of 6 feet from the blocks. The upper blocks have here (and from here to the end) been knocked over into the harbour, and have not fallen towards the north.

11. From 3,000 feet to the actual end 3,870 feet, the lower courses remain in fair order, but a sort of hollow or ditch has been scoured in the rubble base in many places at a distance of 3 to 6 feet from the blocks, and in many spots the lowest block is undermined. The action of the waves against the wall has without doubt been felt at a depth of 24 feet below low water.

12. At the extreme end, which is founded at a depth of 25 to 26 feet below low water, the quadrant or corner block has stood well, but has settled down $2\frac{3}{4}$ feet.

Also twenty-one rows of blocks at the back of the quadrant remain in fair regularity on the outer side. On the inner or harbour side the top courses, and often the second and third courses, have been sent flying into the harbour. The rubble base at the very end was, before the storm, piled up 4 feet above the bottom of the blocks, and it is now scoured out to 4 inches below the blocks in one spot.

13. THE PIER HEAD.—The pier head, by which I mean the last 150 feet of the pier, has stood the sea fairly well, and has failed by sheer force of blows. It is true that only the northern half of it remains, but that remains with much regularity. This is the deepest founded part of the pier, it is the widest section, and on a wider rubble base than the rest. These add to its security. But another reason may be given besides, viz., that Mr. Parkes sanctioned the use of a greater quantity of cement per block in this part of the work, and as a consequence the blocks have not broken so much as in the other portions of the ruined wall.

14. The ruin of blocks along the inner or harbour wall of the pier has prevented my getting many observations of the bottom, but where Mr. Beardmore has sounded at present it seems that the rubble base has not been disturbed. This is clearly the case at the place where the north row of blocks have fallen over northward.

15. NORTH TITAN.—The Titan crane went completely over during the 12th November, and is now buried by the blocks of the pier head. It is useless to speculate on how it came to fall, but I fancy that first the hind wheels gave way and it then capsized, afterwards to tumble over in the general ruin.

16. SOUTH PIER DAMAGE.—There remains a greater length of the south pier intact than of the north, which no doubt is due to the protection given by the latter. The wall stands quite secure to 2,550 feet from the commencement, and there has been no opening of the centre joint as at the north pier. Up to nearly 2,800 from 2,550 there remains the inner or north row of blocks standing secure, but the outer row has been knocked over outwards. There then follows a gap of about 200 feet where the blocks have fallen southward in such confusion that at present I cannot say what has occurred, nor whether the bottom blocks remain in position.

17. Following the foundation outwards we next come to 100 feet where there appears to be no variation in the lower blocks which are the same as when set. But from this point (3,100) outward there is much undermining of the rubble on the outer wall, the depth of scour being in some places as much as 3 feet below the bottom of the lowest block. Throughout the remainder of the pier where damage has occurred the blocks have fallen inwards. From 3,100 to 3,140 there is much scour and undermining of rubble, whereas from 3,140 to 3,200 the rubble is heaped up against the blocks. There does not appear to be any place where the bottom blocks have actually disappeared, but the amount of sinking is most remarkable.

18. SOUTH PIER HEAD.—The actual end of the south pier has suffered severely, although founded at a depth of 26 feet below low water. The lower blocks alone

remain, and these are undermined by the eddy round the end. The upper blocks at this place have fallen over in hopeless confusion, and the whole seems to have sunk very much.

19. But the wreck of the south pier is not so great as of the north even in the outer portion, except at the very end, as there remain three sections or islands in the whole damaged length of 1,400 feet, the aggregate length of which is 210 feet. Whether this is in any way due to the fact that the base is chiefly formed of the Pallavaram stone instead of laterite I will not venture an opinion, but this difference between the two piers does exist. The first of these islands is 40 feet long and is at the end of the curve, at a distance of 3,020 feet from the commencement, where the bottom seems to have been undisturbed. Then again at 3,370 feet there remains a portion of the pier fairly complete for 50 feet, but greatly sunk down. Here there is no undermining of the base. Again at 3,720 feet from the commencement there is a length of about 100 feet of the pier which is hardly damaged at all, but sunk down to almost high water level. The rubble base at this point has not been scoured away from the bottom blocks. From this point to the end at 3,950 feet there has been very great settlement, but at present I cannot accurately give the amount. It appears to be quite 3 feet 6 inches. Levels will be taken when practicable.

20. SOUTH PIER TITAN.—The south Titan crane has fallen over into the harbour where it stood, and is not so much buried with blocks as the north crane. It is quite possible that this machine may be recovered.

21. DAMAGE TO COAST, NORTH.—The devastation caused by the sea of the 12th along the coast to the north is very great, but the harm done is almost entirely the result of actual wave blows, not of erosive action. The railway that we had constructed to carry material to the protective works is almost entirely destroyed, but the materials will be saved. The revetment along the road by Mr. Coleman's house is much flattened down, and the walls of compounds beyond are broken down by the waves washing over.

22. The sea encroached badly opposite the Biden Sailors' Home and all along that portion of the coast.

23. Further to the north the damage was not so serious. I have had many applications for repairing the walls which the sea has demolished, and I suppose I ought to repair them again as I did so in 1879. But it is pretty certain that, if there had been no harbour at all, such waves as we had on the 12th would have done much damage.

24. BUOYS.—Amongst other damage done in this storm there were six of the new buoys carried away. It is hardly necessary to say that they did not drag their moorings, but in every case some part of their chain gave way. The large buoy that was moored to four screws was one of the first to come ashore, and it is clear that the shackle of the chain failed in this case. My divers have not succeeded in getting the chain up yet as it buried itself in the sand when it fell. Four of the other buoys failed by the shackle giving way, and the sixth buoy failed by the mooring ring breaking.

25. The chains and shackles of these buoys are of first-rate workmanship and material, but there is no doubt that the pins of the shackles worked free, although secured in their places by a small turned pin of steel. This is generally split at one end to prevent its working out, but in these moorings there is no such split. The cables of all the buoys were rather taut, but it was absolutely necessary to have them so taut that the swivels were clear of the ground at low water. The buoy to which the two steamers were moored came ashore in the evening of the 12th.

26. MESSAGE TO MR. PARKES.—I telegraphed to Mr. Parkes on the 12th as follows:—"Heavy sea. Both Titans gone. Much damage to piers." And again on the 14th I telegraphed more details and of the sad loss of the steamers and crew. I received on the 18th the following message from Mr. Parkes:—"Passage taken 9th December. Wire, when known, state of remaining courses in damaged parts," and to this I have replied as concisely as I could.

27. More will be known when all our levels and sections have been plotted, but at present I have given all the information I have been able to get by means of divers and soundings. It is perhaps rather general, but I trust that it will serve to show the degree and nature of the damage done. In the meantime greater details are being obtained every day by Mr. Beardmore who is constantly afloat.

28. There are some protective works that might be done to the remaining portion of the north pier, but I really hesitate to do anything until Mr. Parkes has seen the work as it was on 13th November.

29. I forward some photographs of the damaged work with their descriptions written on the back. They form a painful contrast to the photograph I recently had the honor of submitting taken on 8th October.

No. 106. ORDER THEREON, 23rd November 1881, No. 2927 W.

RECORDED, in continuation of G.O., No. 2854 W., dated 15th November 1881, and a copy furnished to the Secretary of State.

2. A fully detailed report accompanied by explanatory plans and sections will be submitted as soon as these can be prepared. Meanwhile, and pending Mr. Parkes' arrival, the only work to which it seems desirable that Mr. Thorowgood should devote himself, in addition to the investigations he is now engaged upon, is that required for protection north of the harbour and for repair of damage in that direction.

(True Extract.)

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

To the Superintendent of the Madras Harbour Works.
„ Marine Department.

Exd. E. C. Shunker.
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BUILDINGS AND ROADS.
CIVIL WORKS.

Govt. of {1881} Madras.

PUBLIC WORKS.

To

THE SUPERINTENDENT OF THE
MADRAS HARBOUR WORKS,

&c., &c., &c.

Dated November, 23rd.

Issued

Recd.

Encl.

G.O., 23rd November 1881, No. 2927 W.

NOVEMBER.

Nos. 105-106.

Madras Harbour Works.—Report from
Mr. Thorowgood regarding the damage to
the —, recorded with remarks.

GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

25th November 1881, No. 2956 W.

Buildings and Roads.
Civil Works.

Read the following paper :—

No. 121. Despatch from the Most Honorable the Secretary of State for India.

Public Works,
No. 35.

INDIA OFFICE, LONDON,
27th October 1881.

SIR,—Upon receipt of your Excellency's Public Works letter, No. 51, dated 17th August last, your suggestion that Mr. Parkes should be deputed to Madras to watch the effects of the next two cyclone seasons upon the Harbour Works was communicated to that gentleman.

2. In reply, I have received a letter from Mr. Parkes, in which, while stating his willingness to go out whenever his services could be usefully employed, he expresses an opinion that no good would result from his deputation at the present time. A copy of Mr. Parkes' letter is enclosed. Its tenor seems to me to be well founded, and

Dated 28th September 1881.
I do not feel that I have before me any sufficient reason for calling upon him to proceed to India at this time.

3. As regards the comparisons that have been drawn between the sections of the Madras and the Colombo breakwaters to the disadvantage of the former, I will content myself with referring you to Mr. Parkes' letter of 4th August last, which was transmitted to you with my despatch, No. 26, of the 24th idem, and particularly to what is said by Mr. Parkes in paragraphs 12 and 13 of that letter.

4. Mr. Parkes has also addressed a letter to me, dated 28th September, in reference to the orders, which were issued by your Government (20th August 1881, No. 2077 W.) directing Mr. Thorowgood to suspend action on instructions which he had received by telegraph from Mr. Parkes on a detail of construction. It appears that Mr. Parkes' instruction had been carried out before your orders were received, but Mr. Parkes thinks that these orders were an interference with his proper responsibility, and I am disposed to agree with him.

5. I must further remark that the reasons which have induced you to defer the institution of a Port Trust or Local Board of some kind for the administration of the harbour, do not appear conclusive.

6. Although it be possible, or even probable, that additions will be required to the engineering work, the harbour is already used, and affords shelter. No dues can be levied except under the authority of some law, and the application of the law to the complicated and often conflicting interests of those by whom the charges will be borne should in my opinion be entrusted at the earliest possible time to a regularly constituted and thoroughly responsible Board of Management.

I have, &c.,

(Signed) HARTINGTON.

His Excellency the Honorable the Governor
in Council, Fort St. George.

From W. PARKES, Esq., M. INST. C. E., Engineer-in-Chief, Madras Harbour Works, to the Under Secretary of State for India, dated 23, Abingdon Street, 28th September 1881.

Madras Harbour.

I HAVE the honor to return, herewith, the papers forwarded to me, with your letter of 23rd instant, and I also beg to enclose for perusal, as having an important bearing on the same question, copies of a letter from myself to Captain Taylor, dated 10th June, and of a printed paper containing one from Captain Taylor to the Madras Government, a memorandum by Colonel Sankey, R.E., and the order thereon, dated 1st August.

2. The Government of Madras are of opinion that my presence in Madras is highly desirable from "probably the 15th October next till at least the end of the spring cyclone season, say, 15th May 1882."

3. The grounds for this opinion appear to be that questions have arisen, or may arise based on the following facts:—

1. That the Madras breakwaters are 10 feet narrower than that in course of construction at Colombo.

2. That the rubble base at Madras had been on one occasion acted on by the sea.

3. That some settlement had taken place near the end of one of the breakwaters.

4. That some further erosion had been observed in the shore beyond the completed portion of the revetment north of the harbour.

5. That some disappointment appears to have been felt as to the imperfect shelter afforded, and that the question may present itself whether it may not eventually be deemed desirable to undertake the construction of additional works.

4. It is satisfactory to find that the first four of these facts do not, in the opinion of the Government, "give rise to any doubt as to the stability of this great work," and, with regard to the fifth, the opinion of Captain Taylor, that the advantages of the harbour even in its present state "will richly repay the dues in the shape of landing and shipping charges and increased port dues," seems to be conclusive against any great urgency in the demand for supplementary works.

5. So far, therefore, I would submit that the statements made in the various papers do not very clearly indicate what particular questions of immediate urgency require my personal investigation on the spot.

6. I have not been satisfied, however, with this negative result, but have myself carefully reconsidered all the questions which still remain open, and have been unable to discover any of which my presence at Madras would materially facilitate the solution. I would most respectfully submit that I am the only competent judge of how far the voluminous information in the form of letters, returns, plans, measurements, &c., which come to me from Madras every week requires to be supplemented by personal observation. From time to time this is necessary, but I do not feel it to be so at present, and the papers under consideration suggest no new questions whatever.

7. The necessity of my being at Madras during the cyclone seasons is suggested, but I think the idea fails to take a practical form when more closely examined. The twelve cyclone seasons, of which the very competent executive staff has already had experience, in every one of which there was more or less rough weather, and sometimes very heavy seas, have only served to confirm our confidence in the work as executed to withstand even much heavier seas than those to which they have been exposed; and there has been definite evidence of the effect of these latter, although the actual breakwater works have never been damaged. Whenever the real test of a "first-class cyclone" is brought to bear it will show, what we do not at present know, whether there is any weak place in the work, and if there is, we may be sure that it will also suggest how the weak place may be strengthened.

8. But this knowledge cannot be obtained by the most experienced observer watching the sea breaking over the works, even if this much could be witnessed, which is doubtful. It must be based upon the careful surveys made during the subsequent calm. In the event of any serious damage to the works I need not say that I should be ready, at any personal sacrifice, to do what might appear to be best for determining on the mode of remedying it, and preventing its recurrence. But at present I cannot imagine that my presence at Madras would enable me to suggest anything to put the works in a better state to bear the test.

9. With regard to the five points put forward as grounds for my visiting Madras, I may remind you that I have already, on 4th August reported on the first, giving my reasons for the adoption of the 24-foot width of breakwater. I did not mention the second, the action on the rubble base, in that report, because my description of the occurrence had been quoted in full by Captain Taylor and Colonel Sankey in their memorandum, and I thought that the simple statement of facts might speak for itself. A hole was scoured out from the rubble base at a great depth, but in a position and under conditions which would be materially altered in the

completed work. It was evidence of a great destructive force of sea, but at the same time of the ample provision made against its effects.

10. The third and fourth points were dealt with in my letter to you of 1st September, based on the telegraphic report of the proceedings at the Legislative Council, which appeared in the *Times*. On the fifth point Captain Taylor's testimony is all I can want, but I may mention that it is confirmed by Mr. Beardmore, who, at my request, made some special observations on the shelter afforded by the piers.

11. There is one other point which is not alluded to in the letter of the Government, but of which a good deal is made in the newspaper reports of the proceedings, viz., the supposed collection of sand or silt in the harbour. In my letter of 1st September I gave an emphatic denial to the assertion of its existence. To this denial I adhere in substance. But what I meant specially to negative was the supposition, which is deeply rooted in the minds of many persons, that sand finds its way into the harbour by the entrance. This would be the only legitimate application of the term "silting," and I am perfectly satisfied that no such action is going on. But, since I wrote that letter, I have been informed of some further changes of the shore line within the harbour, which have not as yet been satisfactorily explained, though I have no doubt they will be. If I had known of these changes I should have taken care to define the limits of my assertion that not a grain of sand had entered the harbour. It is quite certain, however, that, though these changes of the shore line may give a temporary handle to an adverse critic, they cannot be due to any serious deteriorating action.

12. On the whole, then, I feel bound to submit my conclusion that there is not sufficient justification for the cost of my visiting Madras at the present time. I should have no personal objection to it if sufficient reason existed, and if there existed in the minds of the authorities at Madras any serious misgivings as to the success of the works, which my explanations, after further local investigation, were likely to remove, that would be a sufficient reason, but the papers referred to me give no expression to such misgivings. On the contrary, Captain Taylor's letter is most reassuring upon the only point on which a doubt seemed to exist, viz., the sufficiency of the shelter for the present requirements of the trade. The suggestion that further works may be required fully to develop the advantages of the harbour is rather to the credit of the scheme than otherwise, but it would be premature to discuss the details of such further works till their want is felt. I would express a hope, therefore, that the Government of Madras will be satisfied to allow me to watch the progress of events as hitherto, and I pledge myself to allow no personal considerations to prevent my asking for the sanction of the Secretary of State to my visiting Madras whenever I think that my doing so will be advantageous to the work.

From W. PARKES, Esq., M. INST. C.E., Engineer-in-Chief, Madras Harbour Works, to the Master Attendant, Madras, dated 23, Abingdon Street, 10th June 1881.

IN his recent letters to me, Thorowgood has given me the results of his observations on the amount of shelter afforded by the nearly completed piers during the southerly and easterly seas lately prevalent. He expresses himself as somewhat disappointed in the effect produced, and signifies that a similar feeling is expressed in other quarters.

Too much importance must not be attached to such expressions of disappointment. The anticipations with which the still incomplete reality is compared were necessarily based on very indefinite grounds, and some disappointment is quite consistent with the fact of very important practical results having been attained.

But I think the existence of these feelings of disappointment makes it desirable that there should be some authoritative statement of the positive results which have been already obtained, and of the degree of further improvement which may be anticipated from the completion of the works.

To defer this till the tiers are complete would virtually be to defer it for a year, for it will not be till May 1882 that the seas will again be prevalent from the quarters which are most complained of. By that time the Harbour Works establishment will be broken up, and if any question should arise it would be discussed at a disadvantage. It cannot now be difficult to make allowance for the difference between the present opening of 750 feet and the ultimate one of 550 feet in admitting the swell.

What I would suggest, therefore, is that you should report to the Government how far, from your own observation, you think the number of ships which may be expected under ordinary conditions of trade to be in the harbour at one time can be berthed in water sufficiently calm to allow of cargoes being discharged and shipped at all-ordinary times, and how far, at the same time, the landing jetties, or at least one of them, will be sufficiently under shelter to allow the cargo boats to lie alongside them. You would thus indicate the limits of the accommodation which the harbour will afford, and from this a judgment could be formed as to the best way of extending those limits immediately, if necessary, or at some future time if an increased trade should call for it.

If your opinion be that the works as now sanctioned will suffice for the immediate requirements of the trade, the immediate object for which the harbour has been constructed will have been attained, even though the results be not quite so much in excess of that immediate object as you or I, or others, may have pictured to ourselves.

I need not tell you that there are various ways of making the shelter more perfect by supplementary works, the cost of which would be small compared with the amount already expended, but it would be premature to discuss the relative merits of these until the necessity for them is shown to exist.

No. 121-A. ORDER THEREON, 25th November 1881, No. 2956 W.

No. 71, dated 15th November 1881.

" 74, " 23rd " "

RECORDED, with reference to the Despatches to the Secretary of State quoted in the margin.

2. The subject of paragraphs 5 and 6 of the Despatch from the Secretary of State will be considered in connection with the report of the Committee to be submitted under G.O., No. 2512 W., dated 14th October 1881, and in the light of such further information as may be before the Government after the works shall have been inspected and reported on by the Engineer-in-Chief.

(True Extract.)

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

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

Exd. E. C. Shunker.
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BUILDINGS AND ROADS.
CIVIL WORKS.

Govt. of (1881) Madras.
PUBLIC WORKS.

To

THE SUPERINTENDENT OF THE
MADRAS HARBOUR WORKS,
&c., &c., &c.

Dated November, 25th.

Issued

Recd.

Encl.

G.O., 25th November 1881, No. 2956 W.

NOVEMBER.
Nos. 121-121-A.

Madras Harbour Works.—Despatch from the Secretary of State for India regarding the necessity of Mr. Parkes' presence at Madras during the cyclone seasons from 15th October to 15th May 1882, recorded with remarks.

GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

21st December 1881, No. 3169 W.

Buildings and Roads.
Civil Works.

Read the following paper:—

No. 81. From F. N. THOROWGOOD, Esq., M. INST. C.E., Superintendent, Madras Harbour Works, to the Secretary to Government, Public Works Department, dated Madras, 10th December 1881, No. 72 W.

I HAVE yesterday received G.O., No. 2954 W., of November 25th, 1881, in which appears a letter from the Master Attendant to Government referring to the Harbour buoys.

2. I must beg to be allowed to correct Captain Taylor in what he has represented me as saying, Mr. Parkes's written instructions to me regarding the large buoys were that "you must keep the swivels of the bridle chains clear of the ground." The necessity of this is obvious, as it is to allow the buoy and chain to revolve freely on the swivel, which would not be the case if the swivel lay on the ground.

3. When I found that Captain Taylor thought the large buoy was moored too taut, I wrote to him and drew his attention to the necessity of keeping "the swivel of the bridle chain clear of the ground." I was perfectly aware that the *ground shackles* might be anywhere, and had received Mr. Parkes's views on that point also.

4. As Captain Taylor's letter now reads, it would seem that I insist on lifting the "ground shackles," and that Mr. Parkes does not so insist, which places me in the apparent position of insisting on an absurdity and of going counter to Mr. Parkes's orders. What I in reality have done is to carry out his instructions by hanging the swivel clear of the bottom.

5. With reference to the strain on the buoy referred to by Captain Taylor, I cannot tell how he arrived at 6 tons load, but I must remark that the load was not sufficient to sink the buoy to its proper line of floatation, so the strain was less than was intended for similar buoys in $7\frac{1}{2}$ fathoms of water.

6. I would also remark that the chain did not break, but the shackle pin came out owing, as I believe, to the peculiar method of fastening.

7. I would very respectfully ask that these corrections may be recorded.

No. 3018.

* To be returned.

REFERRED* to the Master Attendant, Administrative Department, Madras, for any remarks he may wish to offer.

14th December 1881.

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

No. 81-A. From J. H. TAYLOR, Esq., Lieutenant, R.N.R., Master Attendant, Administrative Department, to the Secretary to Government, Public Works Department, dated Madras, 16th December 1881, No. 11235.

Mr. THOROWGOOD having forwarded me a copy of a letter he has addressed to Government, in the Public Works Department, regarding the swivels of the bridle chain attached to the moorings, I beg to acknowledge that I had not read his letter aright, and that, when I considered that his letter and Mr. Parkes's instructions were at variance, I made a mistake. I have now been furnished with a rough sketch of

the connection, and I see the swivel is attached to the large ring to which the four chains are united. But while admitting my mistake, I must be allowed to say that it does not in any way interfere with the important question of tight mooring, to which I attribute the accident on the 12th, and the evil reputation that hangs over the moorings, which reputation must be cleared up before any use can be made of them. The swivel is certainly in the wrong place, it should be near the buoy. Of course being where it is no change is worth making now, but another swivel must be introduced higher up, and the buoy allowed fair play. The drawing of the pin of the upper shackle, if that was the fault, must be gone into. I consider the question of the mooring to be of vital importance, and beg to suggest that an inquiry be held as soon as convenient while what evidence can be procured is still available.

2. The original letter from Mr. Thorowgood referred to me for remarks is herewith returned.

No. 82.

ORDER THEREON, 21st December 1881, No. 3169 W.

MR. PARKES will, as early as possible after his arrival from England, submit a report on the Harbour Works, with special reference to the effects of the storm of the 12th and 13th November 1881.

2. In doing so he should deal with the subject in generally the following order:—

1st, the effects of the storm on the works;

2nd, the points of the original design which having proved defective now call for modification;

3rd, whether the shelter against wave disturbance within the Harbour has been sufficiently provided for in the original design;

4th, whether the details of the mooring arrangements require modification with reference to the objections urged by the Master Attendant in the marginally quoted correspondence;

G.O., No. 1797 W., dated 21st July 1881.

" " 2484 W., " 3rd Sept. "

5th, the condition of the foreshore north of the Harbour;

6th, the foreshore within the Harbour, and whether the plan of jetties now under execution is in all respects suitable;

7th, the plan which under each of the foregoing heads it would now seem best to adopt for completion of the works, with a statement of the approximate outlay and time required for execution.

3. To enable Mr. Parkes fully to prosecute his inquiries such of the past correspondence in the office of the Chief Engineer and Secretary as he may require will be placed at his disposal. He will also be authorised to call on any Government officer for information likely to be of service to him.

(True Extract.)

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

To the Engineer-in-Chief, Madras Harbour Works.
" Superintendent, Madras Harbour Works.
" Marine Department.

Exd. S. T. Austin.
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BUILDINGS AND ROADS.
CIVIL WORKS.

Govt. of {1881} Madras.

PUBLIC WORKS.

To

THE ENGINEER-IN-CHIEF, MADRAS
HARBOUR WORKS,
&c., &c., &c.

Dated December, 21st.

Issued

Recd.

Encl.

G.O., 21st December 1881, No. 3169 W.

DECEMBER.

No. 81-82.

Madras Harbour Works.—Mr. Parkes requested to submit, as early as possible after his arrival from England, a report on the —, with special reference to the effects of the storm of the 12th and 13th November 1881.

Presidency Public Works
Workshops
Madras 20th February 1882.

N^o 2939 W.

From

The General Superintendent
Public Works Workshops.

To

The Master Attendant,
Administrative Department,
Madras.

Sir, I have the honor to inform you that I have examined the Diving Bell and Pump in the Marine Stores.

The Pump is perfectly useless and irreparable. The Bell would require all the fittings renewed, and even then it would, in my opinion, be of little use in examining the foundations of the Harbor Walls, as there are no windows on the sides of the Bell.

I have seen

(D^y) W. H. Baddeley Esq. R. E.

General Supt. P.W. Workshops.

True Copy

[Signature]
Master Attendant
Administrative Department.

M^{rs}

Administrative Department.

MADRAS,

Marine Office,

23rd February 1882.

No. 1542

From

THE MASTER ATTENDANT,

ADMINISTRATIVE DEPARTMENT,

Madras.

To

The Secretary to Government,
Public Works Department,
Chennai.

SIR,

With reference to my letter No. 976, dated 4th instant, I have the honor to forward copy of a letter from Lieutenant Baddley, General Superintendent of Public Works Workshops, No. 2939 W, dated 20th idem, reporting on the un-serviceable state of the Diving Bell.

I have the honor to be
Sir,

Your Most Obedient Servant

W. J. M.
Master Attendant
Administrative Department.

ms

1226/12

From

THE MASTER ATTENDANT,

ADMINISTRATIVE DEPARTMENT,

Middletown,

To

THE

Dated

Received

No.

188

(188) DEPARTMENT.

No 518 Waj 27th Feb 1882

From

P. W. b. No 1226
THE MASTER ATTENDANT,
ADMINISTRATIVE DEPARTMENT,
Madras.

To

THE CHIEF SECY. TO GOVERNMENT,
P.W. MARINE DEPARTMENT,
Fort Saint George.

Revised
OKH
24/2/82

No. 1542.

Dated 23rd February 1882.
Received 24th

No.

B. No 518 Waj 27th Feb 1882

Subject.

Forwarded copy of a letter
from the Genl. Supdt.
P. W. Stores reporting
on the unserviceable
state of the Dining
Hall.

Entd. in Receipt Regr.

With the order

402851W. 9.12.80
80W. 14.1.81
2927W. 23.11.81
2956W. 25.11.81
3169W. 21.12.81
405W. 25-2.82
No 334C. 9.2.82