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MADRAS RECORD OFFICE

GOVERNMENT OF MADRAS

REV DEPARTMENT

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Not to be folded or roughly handled

*Proceedings of the Madras Government, Public Works Department,
25th February 1873.*

Read the following papers:—

- No. 554. From the Superintending Engineer, 1st Division.
(Here enter No. 2,832, dated 8th November 1872.)
- No. 555. Proceedings of the Madras Government in the Marine Department.
(Here enter No. 16, dated 5th February 1872.)

MEMORANDUM ON VIZAGAPATAM HARBOUR.

PROPOSITIONS for the improvement of Vizagapatam Harbour have been, I believe, several times laid before Government, but hitherto without result, and also without attracting much attention.

The late Governor, Lord Napier, I learned in conversation, had not even heard of it.

It has not been thought worthwhile to direct Mr. Robertson even to visit it while examining the coasts.

Having been for some years employed in coast districts on both sides of the Peninsula, and had my attention particularly attracted to the state of the river mouths—harbours they cannot at present be called—I have naturally taken an interest in this important subject, and trust I may be excused if the interest still remains, although no longer in the department to which they may be thought to belong.

Government is always slow to undertake harbour works for two good reasons among others, namely, that the *cost* is usually very great, and that the results of such works, depending so much more on the action of nature in the locality, on currents, tides, sands, and on the contour of the coast, than on engineering skill in actual construction, are after all so problematical that the *risk* is great.

It is acknowledged by Engineers that much more is dependent on knowledge of local natural circumstances, than on the very best professional talent that can be devoted to it.

It is on these grounds that I venture, with regard to a port that lies daily visible beneath my drawing-room door, to endeavour to call attention to what appears to me a neglected opportunity, and to offer a few suggestions for professional consideration.

2. I submit that Vizagapatam is the most natural, *the most easily formed port on the East Coast of the Peninsula.*

Here the mouth of a small tidal river, from 20 to 28 feet deep for half a mile inland from the bar that closes it, is perfectly land-locked and sheltered by hills; has native docks from time immemorial on its banks, and a population accustomed to both building and repairing ships.

The projecting headland, called the Dolphin's Nose, forms a sheltered bay in front of the river mouth, so that but for the bar there would, for nine months in the year, be smooth water in what may be called the outer harbour of Vizagapatam, and the access to the inner harbour consequently easy, and permitting of the entrance to it being made as narrow as may be thought well.

The course of the river near the sea is so straight that vessels might warp in with a rope taken to them by a boat.

In a small silted-up bay on the south side of the river docks on the European system might probably be excavated with ease, and the same might be done on an unlimited scale in the alluvial flat at the back of the town, or in the disintegrating gneiss of which the other parts of the bank of the river consist.

On the present bar lives and goods have been lost, and great inconvenience and delay are at all times experienced.*

If it was removed the depth of water within is such that large vessels might lie alongside the wharves, and ship cargo over a plank.

The port would be made.

3. All that it needs is to have the bar removed: within it the depth and shelter are all that could be desired.

Is the removal of this bar (not long continuous miles of surf as in Madras, but a bar across the narrow mouth of a river,) so great a difficulty as to be properly left untouched?

It is, I believe, uncertain to what depth it is merely a sand bar, and what amount of rock there may be; but I believe Engineers will at once say that the object being not the clearing of a large anchorage area, but simply the opening of a narrow passage, they would care little whether the obstruction was sand or rock, provided only that natural circumstances were such as to aid in rendering permanent the opening they could with ease make.

Such naturally aiding circumstances, I believe, partially exist and may be partially artificially created.

The bar at the mouth of the river is caused by the opposing action of the outgoing, in-coming, and marine currents.

If a scour outwards, over-powering other currents, could be created, this bar would be swept away.

The river is too small a one to effect this, at any rate with its present undefined sandy mouth.

4. In addition to the action of the river and the tides there are the littoral currents to be considered.

Usually these are very powerful, and are the greatest difficulty and danger Harbour Engineers have to contend with.

Occasionally, however, the force and direction of these currents may be so taken into alliance, as it were, as to aid quite as much as they would otherwise obstruct the formation of a port.

When there is no current whatever the silt from a river mouth must inevitably be continually deposited directly in front of it, and, even when the river is powerful enough to shoot it out to some distance, it is still but a question of time, and that comparatively little, within which the river must by this action close its own mouth; the most lengthy and costly series of sea walls only construct a canal

* The day before the despatch of this letter the largest barque belonging to the port has been driven on shore and wrecked by the action of the surf at the entrance to the river, though there is smooth water both outside and in. The value of this single loss would have sufficed to make the port.

in the sea, and at ever increasing expense artificially continues a contest with the forces of nature to which the financial side of the question cannot but put a comparatively early limit.

But Vizagapatam is happily situated.

It is not without a littoral current, and the current that exists is not an inimical one.

The chief current at Vizagapatam is one that flows northward, as may be daily noted from the colored water it carries past the port.

This current, if properly studied, and taken as it were into our service, will, I submit, do inestimable service.

It will prevent the necessity for a sea-wall at all on the south side of the port, taking, in fact, the place of and doing the work of such a wall.*

It will increase and act with the scour just outside the mouth; and, most important of all, it will carry away northward and seaward all the silt that would otherwise lie at the river mouth in a more complete and thorough way than could be done at enormous cost by a fleet of steam dredges.

5. When other means fail to remove a bar or deepen a river recourse may be had to dredging, or to a simpler, much forgotten, far more economical, and powerful method, namely, assisting a river by means of sub-marine grubbers to scour its own bed deeper.

This may be done in many ways, but I believe the simplest would here suffice.

6. What I beg to suggest is the following:—

The river has already a rocky precipitous bank along the whole of the south side and along half the other.

The remaining portion of the northern side is a spit of sand.

The northern bank should be continued as a straight stone wall along this spit of sand, parallel with the southern, for 300 yards, and at the termination should be so taken as to narrow the entrance to the river to such width as may, on consideration, be found best for obtaining a thorough scour, and yet leaving sufficient space for ships to enter by.

7. Whether the northern wall be then still further lengthened in a direction at an angle of 45, or less, with the littoral current, is a minor subsequent question, which should depend upon observation after the above-named portion had been constructed.

This might or might not be found necessary to shoot the silt of the river further out to sea instead of along the coast.

8. This defining of the form of the river mouth and the contraction of it would probably do something towards removing the bar.

The chief thing, however, that is required is a continuous current of sufficient strength outwards, and this I would propose artificially to obtain by inserting, along half the length of the sea-wall to be constructed on the north side, tidal shutters to admit into the harbour the rising tide, and keep it enclosed when

* in the Baltic is an interesting instance of a spot where the littoral current has been thus utilized.

endeavouring to recede; thus I would admit at least twice as much more water as entered by the open mouth, and compelling the whole to return to the sea by the latter course, would thereby hope to create such a scour there as would certainly perform work that no returning tide could undo.

9. If the confining wall (1), the above described treble ebb-tides (2), and the friendly current (3) do not suffice to keep the mouth open, I would aid the scouring action by the use of some form of "Turkish rake" (4),* or marine grubber, at the time of the ebb, so to assist river and tide as to decide the point.

10. The question of *expense* still remains; but I venture to think the element of *risk* and doubt as to the result of the effect of these four allied forces cannot surely be great.

In this scheme nature has done more than half the work, and nothing expensive nor temporary; no breakwater and no steam dredges are necessary; nothing but a sea-wall of moderate length with shutters (protected, if necessary, by wave screen of six rows of piles), and all this in a sheltered bay, and chiefly inside the river mouth.

The only work requiring some care and skill would be towards the sea end of the wall, where the scour and the depth of water will be greater; I imagine no estimate of these simple works could rise above £10,000, and that they might well be completed within the year.

From both banks of the river any amount of stone can be obtained.

The prisoners in the jail are with difficulty found occupation, and might with advantage be employed on this work.

On the very spot where they would be required to work there are buildings capable of housing 100.

Thus, at the cost of about half the price of one of the steam vessels calling weekly at the port, a safe harbour might be constructed in the middle of the Bay of Bengal, in which, within half an hour of the open sea, vessels of any size might be laid up and repaired.

With slight additional expenditure the European system of docks might be introduced.

11. There is only one possible objection I have heard among those who are locally acquainted and satisfied with the entire feasibility of the easy formation of a port here, namely, that the communications with the interior are few and imperfect, and it is not therefore a natural emporium for trade.

Vizagapatam has always been backward in communications.

But there is no reason in the natural features of the country why this should continue to be the case.

There are now three roads into the interior; and the ranges of hills which come down to within fifteen miles of the coast offer remarkable advantages for the construction of a far better means of transport by the formation of ravines†

* See Report on the works at the Salina mouth of the Danube.

† At Kashi-pore Gorge and elsewhere.

reservoirs, which would supply water in all seasons for small navigation canals throughout the length of the district.

Canals at first of only small width and depth, mere ditches, with passing places every hundred yards of twice that width would permit the passage of boats which in Malabar convey six tons of cargo each,* and they might be constructed for about the same cost per mile as an ordinary road with its bridges.

The incomparable value of water carriage in taking bulky raw produce to a port is well known.

The opening of the port—the only port of refuge between Point Pedro and Calcutta—could not fail largely to increase a trade already not contemptible.†

12. The accompanying rough sketches show the present aspect of the river and the alterations proposed.

The small sum required for this great public work might be found direct by the (1) Government, or by the (2) Municipality by loan, if placed in charge of their own harbour dues, or even by one of those (3) enterprising private individuals not unknown in this district and elsewhere, who value the fame of conferring a public benefit more than wealth uselessly hoarded or childishly wasted.

VIZAGAPATAM,
24th September 1872.

(Signed) E. S. THOMAS,
Madras Civil Service.

No. 555A. REPORT TO ACCOMPANY ESTIMATES FOR IMPROVING THE MOUTH OF THE VIZAGAPATAM RIVER.

THE construction of a groyne at the mouth of the river appears to have been first suggested by the late Master Attendant of Vizagapatam, Captain Pascal, in his letter to the Collector, No. 26, of 20th April 1864; and this scheme for improving the port has been revived by his successor, Captain Waters. The present estimates have been framed at the request of the Collector, under instructions from the Superintending Engineer.

2. Captain Waters now proposes that "a good substantial groyne, to keep the mouth of the river open from the south-west monsoon, should be run out to 19 feet 7 inches on the south side of the river's mouth;" this, he considers, "would break the heavy swell which rolls round the Dolphin's Nose, and causes a heavy surf on the bar. Vizagapatam port would" then "be a safe place all the year round; the water running out of the river in a straight line would be the means of deepening the bar and allow vessels of moderate draught to enter the river;" and there would no longer be any "surf on the bar."

3. "A good substantial groyne," according to the Master Attendant, should be 40 feet broad at its base near the shore, and widen to 62 feet at 700 feet in length, with a top width of 25 feet, and be raised to 12 feet above high water spring tides. The material to be used up to 350 feet is "the largest stones that can be put down in as solid a block as they can be laid," and the outer portion of the groyne to be of stone of all sizes; and his reason for this is the "surf being heavy towards the shore, and the groyne outside only having to encounter the swell." Such a groyne he estimated to cost Rupees 30,000; but states that the nature of his duties will not admit of his undertaking the work.

* Three feet wide and sixty feet long.

† As I write fifty-six native craft of the largest class lie docked or at anchor in the river for the monsoon.

4. In regard to the best position for a single groyne at the mouth of the river Captain Waters differs from his predecessor, Captain Pascal, who recommended "loose stone groyne on the northern side of the entrance." This Captain Waters has "every reason to believe would not be of any use," as "the sand constantly being checked by the groyne would cause the place in time to be blocked up;" and he considers the proper place for the groyne to be on the *south side* of the river from the Dutch Battery; and that it "should be run out into three and half to four fathoms water."

5. Captain Waters states that he does "not consider that littoral currents have anything to do with blocking the bar." He would carry the groyne out 19 feet 7 inches, because "the surf does not break so far; the extreme outer edge of the surf being from 300 to 350 feet." His reasons for making the groyne 12 feet above high water spring tides are, "first, there can be no doubt the groyne will sink; second, the surf will not break over it to displace the stones." "Twenty-five feet on the top would be a good support for a platform, and make the groyne use for tracking ships or boats either in or out of the river, also for landing shipping cargo."

6. The object of the proposed groyne, as I understand it, is that of aiding the natural forces now in operation to maintain the greatest depth of water on the bar that they are capable of producing; and in considering what will be the means of attaining this end, the following particulars may be noticed:—

(a.) The embouchure of the river is probably more or less affected by the waves, the tides, the littoral currents, the land freshes, and the ebb and flow of tidal water from the extensive swamp to the west of the town.

(b.) The catchment basin of the Méghadri river, which flows into the sea at Vizagapatam, covers an area of 220 square miles, which gives a volume of about $3\frac{1}{4}$ millions of cubic yards of water per hour in the great freshes of the north-east monsoon (assuming that only four inches of rain-fall flow off) to be discharged into the sea through a sectional area of about 7,850 square feet; this gives a mean velocity of 3.105 feet per second, or a least velocity of the current close to the bed of 2.25 feet per second, sufficient, according to Du Buat, to sweep forward gravel of 1 inch in diameter. These heavy land freshes produce the most powerful scour at the embouchure, and would be much more efficacious in clearing a channel at the bar if they were controlled and prevented spreading laterally, which, by causing the flood waters to float on the salt water, enfeebles their action on the bottom.

(c.) A continuance of land floods for some days, as is often the case in the north-east monsoon, scours the sand off the bar, and carries it far into the roadway, from whence it is swept by the current round the point of the Dolphin's Nose. When a strong land fresh occurs at low water spring tides, the current in the river has the greatest fall towards the sea, the body of the bar is completely cleared of sand, and the river's mouth left in the best state.

(d.) The freshes of the south-west monsoon are never considerable, and exercise very little influence on the bar, so that during the rest of the year the principal natural cause at work in keeping the bar open is the ebb and flow of tidal water from the salt swamp. I may here mention, as showing the extent of the

swamp, that the principal salt cotaur of the district is in it at about four miles in a direct line from the river's mouth. According to Stevenson, the "sectional area of estuaries at low water bears a nearly constant proportion to the volume of water which runs in and out at each tide, being from $7\frac{1}{2}$ to 10 square feet of area for each million cubic feet of tidal water." Estimated by this rule, the ebb and flow of tidal water over the Vizagapatam bar must be about 305 millions of cubic feet.

(e.) The littoral currents which are, in my opinion, the principal cause of the bar, may be said to be unceasing; as soon as the current from the south ceases, a re-action sets in from the north. Captain Graves, the Master Attendant at Bimlipatam, who has had great experience both as a practical navigator and also in the service of the Marine Department, appears to think that these currents are as often southwards as northwards; and on any temporary cessation of the one current the other at once takes its place. Captain Graves also informs me that experienced divers at Madras state that the whole face of the beach below tide-water mark, down to a depth of about six fathoms, is in a constant state of transition from the action of the littoral currents.

(f.) Strong easterly winds during the five months, October to February, bringing the sand coastwise southward, puts also in agitation that which has been previously lodged on the left bank of the embouchure, and at the same time forces it into the entry. This effect of the easterly winds is strikingly apparent at that period of the year on the beach between Bimlipatam and Vizagapatam; every projecting spur of rock having its northern face then heavily covered with sand, while the southern face is left quite bare. The bar is still further disimproved on the setting in of the south-west monsoon by deposits from the southern current driven in by the tide, and it is then found in its worst state.

(g.) The depth of water in the deep channel at the bar probably now varies from a normal depth of 3 feet to an exceptional one of 7 feet, at low water spring tides. Captain Waters informs me that "the trade of the port has never been stopped by want of water. The least depth of water at any time on the bar is not sufficient to stop the working of boats drawing $2\frac{1}{2}$ feet of water." On the 4th December 1869, about six weeks after the heavy freshes of the north-east monsoon, he found 11 feet of water on the bar. Vessels drawing 6 to 7 feet of water now enter the Vizagapatam river to be laid up for repairs.

(h.) As might be expected, the deep channel at the bar shifts with every change in the littoral current. When that current is from the south, the deepest part of the bar is on the north side of the embouchure, and when the current sets down the coast the deep channel moves towards the Dolphin's Nose; but there is a projecting spur of rock near the Dutch Battery which prevents it approaching very close to that side.

7. I now proceed to give one or two brief extracts from writers on Marine Engineering, confirmatory of my own views on this matter—

"Recent investigations," Professor Rankine states, "tend towards the conclusion that every wave is more or less a 'wave of translation,' setting down each particle of water, or of matter suspended in water, a little in advance of where it picked that particle up. This property of waves accounts for the fact that they heap up sand, gravel, shingle, or such materials as they are able to sweep along,

upon every flat or sloping beach against which they directly roll; that they carry such materials into the bays and estuaries; and that when they advance obliquely along the coast they make the materials of the beach travel along the coast in the same direction."

"If," observes Burnell, "during the advance of immersed substances, and detrital matters in suspension, along the shore, under the double impulsion of the waves and of the currents, these alluvions meet a bay, the still-water existing in the bay will allow the heavier particles to subside; while if, in addition to the comparative tranquillity of the bay, there should exist any subsidiary currents, as in the embouchures of rivers, the remaining matter in suspension will be deposited. *Bars are thus formed*, by the deposition of the alluvions upon the line of junction of the littoral currents with that of the down stream, and the axis of the bar follows that of the resultant affected by the velocity, the volume, and the direction of the down stream."

Again, Rankine states that "the *tidal* currents sweep along with them silt, mud, sand, gravel, and other materials; hence the ebbing tide tends to scour and deepen inlets, and the flowing tide to silt them up; and the prevailing tendency of the tides, like that of the waves, is to choke and fill up estuaries, river channels, and other inlets. A strong fresh water current" (or a reflow of back-water) "maintains a deep channel against this action of the sea; but where that current escapes into the open sea, a *bar is formed* by the action of the waves and tides. "One of the chief objects of harbour engineering is so to manage and modify the action of the tidal currents that the ebb shall become stronger than the flood, and shall *scour deep channels and remove bars*."

8. In accordance with the above quoted authorities, I am of opinion that the littoral currents are the chief cause of the Vizagapatam bar, as they sweep past the mouth of the river laden with detrital matters in suspension, and meet there with the powerful ebb and flow of tidal water caused by the salt swamp. On the other hand, the reflow of backwater is the principal agency now at work in keeping open a channel through the bar. The most important effect of making a deep, direct, and regular channel into the river would be that of increasing the extent of rise and fall of the tide in the swamp, and thus improving the scour on the beach.

9. In the present state of the river whatever tends to cut off or diminish the reflow of tidal water from the swamp is a detriment to the scour at the river mouth, and to the maintenance of a channel at the bar.

I am therefore decidedly of opinion that further reclamations in the swamp should not be encouraged; at least until the mouth of the river has been improved.

10. "In order to increase the depth over a bar," Rankine writes, "piers or breakwaters must be carried out so as to concentrate the current over it, and it is best, if possible, to make the space between those piers *widen inwards*, in order both to hold scourge water, and to serve as a 'wave trap.' When there is only one pier it should run from the *up-stream* corner of the entrance." In a case like that of Vizagapatam, where the current down the coast is almost, if not quite, as powerful and lasting as that up, both equally laden with silt or mud, sand, gravel and other materials, I consider two piers or groynes necessary in order to sweep the bar in deep water, and, if possible, remove it altogether.

11. To remedy the constant state of fluctuation that the bar is subject to, both with regard to the depth of water upon it and the position of the deep channel, I propose, first, a river embankment, 850 feet in length, to be constructed on the left bank of the river, from A to B (see plan), to confine its waters to one invariable direction, without contracting the section of channel beyond what nature has itself provided a few hundred yards higher up, preventing the lateral spread which now enfeebles its action on the bar, and admitting of an increased velocity being employed to deepen the passage at the mouth; second, a groyne in prolongation of the river embankment to be carried out into deep water at 1,200 feet from the shore,

* Altered by Colonel Fischer to 600.

and to be eventually prolonged seawards; and, third, a groyne of 1,000* feet in length, to be carried out as shown on the plan from the rocks near the Dutch Battery.

12. These groynes being carried up to three feet above the highest floods, would assist in confining the river until it had reached deep water, prevent the deposit of sand, gravel, etc., in the channel by winds or currents, and at the same time destroy the surf and secure the safety of passengers and goods being conveyed to and from the landing place. Native craft of considerable size would also then be able to unload in the river.

13. I anticipate that the waves, which now break violently into surf on the steep declivity at the river's mouth, checked and broken by the groynes, would spread and expend themselves without

* Colonel Fischer altered the plan to parallel groynes.

a surf as they advance up the gradually widening channel of approach to the

river's mouth over a gently sloping beach.

14. One of the many advantages that Vizagapatam possesses over most other places for the construction of such works consists in the abundance of good material in the rocky hills close to the site. I would propose to open quarries, and by means of short tramways, convey the stone to the spot where it is to be deposited. The ordinary effect produced by throwing out a groyne is that sand is accumulated on the up side of it, that is in a direction meeting that of the current, until it has filled the angle, when it passes the point and accumulates in the still water behind the groyne; I would therefore carry out these groynes as far as possible into deep water, with a view to such sand as passes the point being swept past the entry, or out to sea by the reflow from the swamp, and I have therefore provided for a length of 1,000 feet.* With regard to the height

* According to the original plan.

of the work, I understand that the best examples of breakwaters now existing only rise a few feet above the water, and as I propose that the faces of the work should, as far as practicable, be covered with hammer-dressed stone of large size, cramped and pinned with iron, and the crown laid with hydraulic cement, I consider a height of 3 feet above the highest floods would be amply sufficient.

The foundation of the groynes to be of stones thrown in promiscuously, and left to form their own natural slope till they appear above low water; above that level to be placed by hand as far as practicable and well packed. I propose cramping and pinning, or using hydraulic mortar for the exposed surfaces, because the chief danger to the face of such a work is that air and water penetrate the joints, and by their pressure and elasticity cause the stones to jump after receiving the blow of a wave.

*Proceedings of the Madras Government, Public Works Department,
25th February 1873.*

15. My estimates show that a single groyne of the description proposed by the Master Attendant would cost Rupees 67,500; while works of the nature I consider necessary could not be constructed for less than Rupees 2,29,800.* I leave to

* The original estimate was 2,44,000 Rupees, and was revised by Superintending Engineer to Rupees 2,29,800.

the Collector, who called for these estimates and who is possessed of statistics of the general trade of the district, the task of explaining the probable effect of such improvements, and showing whether any possible future trade of the port is likely to warrant such an outlay. The present shipping trade of Vizagapatam would evidently furnish no criterion of the probable value of such works, as all the exports of the north and west of the district, which now find their way to Bimlipatam, would at once be diverted to Vizagapatam, and it would doubtless eventually become the chief port of the district.

16. I am also of opinion that the construction of a single groyne, whether to the north or south of the embouchure, but especially the latter, would be a dangerous experiment, for though most useful during the south-west monsoon, when a groyne on the south side would protect boats entering or leaving the river from the great violence of the surf at that period of the year, it might possibly result in the complete blocking up of the river's mouth in the dry season, as the effect of the easterly winds, described above in paragraph 5 (f), thereby temporarily stopping the supply of salt water to the swamp, besides other evils which would no doubt prove most detrimental to the health of the people at Vizagapatam.

17. In conclusion, I would suggest, in view of any outlay being incurred for the improvement of this port, that the Marine Department be directed to keep a register of the levels of high and low water, and of the depths of water in the deep channel at the bar during the months of October, November, December, and January, when the bar is in its best state; also of the velocities of the currents into and out of the backwater at half ebb and half flood. This may be done by the present establishment at little, if any, cost, the currents being measured with a Massey's log, or other instrument, in which the rotations of a fan driven by the current are registered by wheel work.

18. The proposal to construct a groyne at the river's mouth has already been reported on by Lieutenant J. F. Dorward, R. E., in his letter to the Superintending Engineer, No. 570, of 31st October 1870. The Superintending Engineer has also lately personally inspected the site of the proposed groynes, and I believe my present plans and estimate to be in accordance with the suggestions he then made.

19. This report is accompanied by—

- 1 Plan of the mouth of the Vizagapatam river.
- 1 Plan showing sections of proposed groynes and river embankment.
- 1 Cross sections of sand bank at the mouth of the river.
- 1 Estimate of works proposed by the Executive Engineer.

WALTAIR,
8th November 1871.

(Signed) J. BEATTY, Captain, R.E.,
Executive Engineer.

(Revised Copy.)

WALTAIR,
15th January 1873.

(Signed) J. BEATTY, Major, R.E.,
District Engineer, Vizagapatam.

*Proceedings of the Madras Government, Public Works Department,
25th February 1873.*

ESTIMATE No. 31 OF 1871-72.

Revised Estimate of the probable Expense of constructing two Groynes and an Embankment at the mouth of the Vizagapatam River.

MEASUREMENTS.			Cubic Contents.	Particulars of Work.	Rate.	Per Item.	Amount.		Total.
Length.	Breadth.	Depth.					RS.	A. P.	
850	Area. 2104	...	178,712½	I.—River Embankment from the present landing place to mouth of the river near the Ice House.					
850	Area. 63	...	53,550	Embankment on the line AB See plan	...	...	...		
				Deductions for hammer-dressed stone work	...	...	...		
			1,25,162½	or 4,635-17½ cubic yards of loose rubble	2	C. yd.	9,271	4 8	
Feet. 850	Area. 63	...	53,550	or 1,983½ cubic yards of hammer-dressed stone, cramped and pinned with iron or laid with hydraulic cement	7	"	13,883	5 4	
							23,154	10 0	
				Contingencies and Superintendence	20	P. N.	4,625	6 0	
				Total for river embankment					27,780
1,200	Area. 860½	...	1,032,300	II.—Groyne on the north bank of the river near the Ice House.					
	Area. 1,881½	8½	16,463½	Groyne on the line B.C. See plan	...	...	...		
				Ends of do.	...	...	...		
			1,048,763½						
1,200	Area. 189	...	226,800	Deductions for hammer-dressed stone work	...	...	...		
			821,963½	or 30,443-2½ cubic yards of loose rubble	2	C. yd.	60,886	2 6	
1,200	Area. 189	...	226,800	or 8,400 cubic yards of hammer-dressed stones, cramped and pinned with iron or laid with hydraulic cement	7	"	58,800	0 0	
							1,19,686	2 6	
				Contingencies and Superintendence	20	P. N.	23,933	13 6	
				Total for North Groyne					1,43,620
600	Area. 624	...	374,400	III.—Groyne on the south bank of the river near the Dutch Battery.					
	Area. 1,320	6½	8,800	Groyne on the line D E. See plan	...	...	...		
				Ends of do.	...	...	...		

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Revised Estimate of the probable Expense of constructing two Groynes, etc.—(Concluded.)

MEASUREMENTS.			Cubic Contents.	Particulars of Work.	Rate.	Per Item.	Amount.	Total.
Length.	Breadth.	Depth.						
600	Area. 182	...	109,200	III.—Groyne on the south bank of the river near the Dutch Battery.—(Concluded.)			RS. A. P.	
				Deduction for hammer-dressed stone work ...	...	...	...	
			274,000	or 10,148½ cubic yards of loose rubble ...	2	C. yd.	20,296 5 4	
600	Area. 182	...	109,200	or 4,044½ cubic yards of hammer-dressed stone, cramped and pinned with iron or laid with hydraulic cement ...	7	..	28,311 1 9	
				Contingencies and Superintendence ...	20	P. N.	9,792 8 11	
				Total for South Groyne...	...	...	...	58,400
				Grand Total ...	...	...	...	2,29,800

WALTAIR,
8th November 1871.

(Signed) J. BEATTY, Captain, R.E.,
Executive Engineer, Vizagapatam.
(„) J. F. FISCHER, Major, R.E.,
Acting Superintending Engineer, 1st Division

MEMORANDUM BY THE CHIEF ENGINEER.

Bimlipatam.—I have no doubt that theoretically the works which would make the best harbour possible for Bimlipatam would be a jetty of 2,400 feet in length due east from Mackenzie's Tower into 3½ fathom water, where it would be connected with a breakwater of 1½ mile in length, running in a north-easterly direction into 7½ fathom water. The jetty should be of solid masonry up to low water mark, thence of open piling to the breakwater, the inner side of which should be built up of large squared blocks, its outer side only being shaped with a long slope to seaward. The method of construction to be similar to that adopted for the Portland Breakwater.

2. But the cost of such works would be altogether disproportionate to the claims of the existing trade of Bimlipatam, or to its value as a port compared with other Northern ports, such as Cocanada or even Vizagapatam. I certainly do believe that a pier partly open and partly solid carried out according to the Master Attendant's original idea, but built up of large squared blocks on its northern side and costing, with accessories, say 1½ lakhs, would materially improve the port by acting as a training wall for the river current, and by throwing the bar and surf upon it so many yards further seawards. But I should desire previous consideration of the comparative cost, and value to the trade, of a simple pier of open piling to be run out from the southern corner of the town into 4 fathom

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water, which is there within 150 to 200 yards of low water mark. The materials to be used might either be iron or South Australian timber said to be impervious to attacks of the Teredo. The main difficulty and expense likely to be experienced will be as to the means of fixing the foundations, as the rocky bottom which may be reckoned on will preclude the use of screw piles.

3. It appears to me that the comparatively cheap expedient of a pier which has been found useful at such exposed ports as those of Madras and Calicut, may realize as much as can be expected for Bimlipatam with reference to the nature and amount of its trade.

4. *Vizagapatam.*—The subject of improving the harbour of Vizagapatam has been brought forward by Mr. E. Thomas, the Judge of that place, in a memorandum dated 24th September 1872, written apparently in ignorance of the propositions made by the Master Attendant of that port and the present District Engineer which were summarily disposed of in the Marine Department as too expensive—See G. O. No. 16 of 5th February 1872. And in neither of these schemes is any allusion made to the propositions of the Collector and District Engineer referred to Sir A. Cotton for report in G. O. No. 918 of 18th April 1859, and disposed of in his report recorded with G. O. No. 1,900 of 8th August 1859.

5. The general conclusions arrived at in that paper were, that it was worthwhile spending about Rupees 30,000 upon the port, and that this could be done to best advantage by running out a breakwater from the Dolphin's Nose; Captain Vertue's proposal having been to throw out a stone groyne 440 feet in length, at an estimated cost of Rupees 23,500, on the opposite or northern side of the river mouth. The propositions laid before Government a year ago consisted of a river embankment 850 feet long costing Rupees 27,780, and its prolongation into deep water by a groyne 1,200 feet longer, estimated to cost Rupees 1,43,620, on the north side; with a groyne of 600 feet on the south side, run out from the Dutch Battery into a depth of 16 feet at high water spring tides, to cost Rs. 58,400. Mr. Thomas's proposal is to spend about 1 lakh in a river embankment and groyne on the northern side about 300 yards in length; differing from the first portion of the last-mentioned scheme only by the addition of tidal shutters along half its length to admit the rising tide as freely as possible into the mouth of the estuary. Thus it will be seen that a three schemes hitherto submitted to Government contemplate a northern river wall and groyne; one of them deprecates a single groyne only, wherever placed, as likely to render the bar worse than at present (see Collector's letter No. 957 of 26th December 1871, paragraph 2), and adds a groyne on the south side; while Sir A. Cotton years ago condemned any scheme but one consisting of a breakwater of about 200 yards run out from the salient point of the Dolphin's Nose, *i. e.*, on the southern side of the harbour.

6. So far as can be judged from the facts brought forward, I am decidedly of opinion that a work on the southern side of the river mouth is alone advisable; but there is not sufficient detailed information forthcoming to enable me to form a decided opinion as to its exact nature, position or length. Major Vertue's chart, embracing an unnecessary extent of coast, is laid down on too small a scale to show accurately such soundings as have been taken, and none are given on the south side between the river mouth and the Dolphin's Nose; while the survey and longitudinal

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sections accompanying Major Beatty's report are inexact as to plan, and inconsistent as to soundings. Mr. Thomas remarks that in planning harbour works much more is dependent on knowledge of local natural circumstances than on the very best professional talent that can be devoted to it. It would be more correct to say that no professional opinion can possibly be formed without a precise knowledge of local natural circumstances; and that when these are known real professional knowledge is shown by drawing correct conclusions from them.

7. I am led by the facts recorded in Major Beatty's thoughtful paper to arrive at a very different conclusion from his, and one agreeing with Sir A. Cotton's, in placing whatever works are to be carried out on the southern side. I agree with Major Beatty that, if two groynes are to be thrown out, the southern should overlap the northern considerably; Lieutenant-Colonel Fischer's argument in paragraph 4 of his letter No. 2,173 of 12th October 1871, having failed to take into consideration the difference between a southern groyne and an ordinary projecting rock, in that the former would have a current running along its northern face to sweep it clean. I anticipate no other effect from a southern groyne than that of throwing out the bar as many hundred feet beyond the present bar as it is long, a position in which the depth over it would be greatly increased and the surf on it proportionably diminished. But to guard against a proportionate advance on the northern sandy beach, and contracting of the space between it and the bar in its new position, it will be necessary not to connect the southern groyne solidly to the main land, but to leave an interval bridged over by a pier on piles through which there shall always be free action of tide and current. What shall be the extent and material of such open pier, what the extent of its solid prolongation, what their exact direction and position with reference to the main land, are all details that cannot be worked out without a good survey and soundings all along from the Dolphin's Nose to the northern extremity of the bar.

8. I recommend that the collection of such materials for further reliable plans and estimates be undertaken by a special officer placed at the disposal of the Inspecting Engineer for Ports and Communications for ghaut work in Jeypore, in the intervals when such work cannot be prosecuted. It would appear from the commercial statistics supplied by the Collector that the value of exports at Vizagapatam has averaged over 8 lakhs in the last five years against 6 lakhs for the five years previous, and that of imports more than 10 lakhs against 7 lakhs per annum, while the average of exports at Bimlipatam for ten years past is 20 lakhs, and the last five years average of imports equal to that of Vizagapatam, the excess being due to the resort of European shipping to the former harbour to treble the tonnage of those frequenting Vizagapatam. The facilities for improvement of the latter harbour at a moderate cost, say within 1 lakh of Rupees, appear to me greatly to outweigh those offered at the former; and with a fair improvement to the communications between the two places, it is presumable that if Vizagapatam river were made easy of access to vessels of not more than 12 feet draught it would supersede the rival port almost entirely. It would consequently be desirable to concentrate operations at Vizagapatam, at all events in the first instance.

(Sigr. G. W. WALKER, Colonel, R. E.

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No. 556.

ORDER THEREON, 25th February 1873, No. 603.

CIVIL WORKS, No. 34.

ORDERED that copies of these papers be printed and forwarded to the Inspecting Engineer for Ports and Communications,

who will arrange for the preparation of the survey and soundings at Vizagapatam.
2. The Marine Department will be requested to provide Rupees 600 for the purpose from Port Funds for expenditure in 1873-74.

(True Extract.)

G. W. Walker Colonel, R.E.,
Secretary to Government.

To the Inspecting Engineer for Ports and Communications.
" District Engineer, Vizagapatam.
" Revenue Department.
" Marine
" Controller of Public Works Accounts.
To E. Thomas, Esq.

Exd. E. C. Shunker.

obt. of 1873 Madras.

PUBLIC WORKS.

THE INSPECTING ENGINEER FOR
PORTS & COMMUNICATIONS,

&c., &c., &c.

dated February 25th.

and 1st March

Encl.

G. O., 25th February 1873, No. 603.

FEBRUARY.

Nos. 554-556

Vizagapatam Harbour.—The Inspecting
Engineer for Ports and Communications
arrange for the preparation of survey and
soundings at Vizagapatam and Marine
Department to provide Rupees 600 for the
purpose from Port Fund for expenditure in
1873-74.

Comm. to the
Board of Revenue

3rd March 1873

10 Feb. 092. 06. 1873