St. Peter's Church

Sailors Biden Home

RAILWAY TERMINUS

3. FM

4. FM

5. FM

6. FM

7. FM

8. FM

Messageries Imperiales

P I E R

Custom Office
Master Attendents Office
High Court

Messrs. Arbuthnot & Co.
Messrs. Boanbridge & Co.
Oriental Bank
Mssrs. Shand & Co.

Pump Office

Govt. Granary.

Church of Scotland India Mission

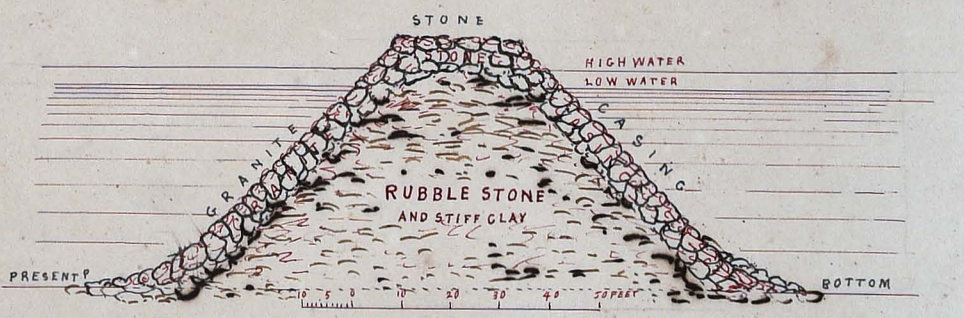
Messrs. Parry and Co.

Head of present Stone Pile Pier

Proposed Jetty to Chetpet Road

Light House.

FORT ST. GEORGE.



PLAN OF THE TOWN AND ROADSTEAD of MADRAS

SHEWING THE HARBOUR PROPOSED

BY

Mr ROBT. BALDREY.

1000 500 0 1000 2000 3000 Feet.

NOTES

ON THE HARBOUR PROJECT

FOR MADRAS.

Pointing out the Defects of the Plan,

PROPOSED BY

MR. PARKES

AND REMEDIES SUGGESTED.

WITH TWO PLANS

BY

MR. ROBT. BALDREY.

Defects, like weeds pull out, their roots lay bare
Good qualities will of themselves take care.

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PREFACE TO NOTES ON THE PLAN OF HARBOUR PROPOSED BY MR. PARKES FOR MADRAS.

I AM fully alive to the difficulty of my self-imposed task, and conscious of my inability to give suitable expression to my thoughts and ideas on a subject, the importance of which demands an abler pen than mine to depict. But as nothing has been done to warn the public of the impending evils which, I believe and feel assured, will result on the completion of the close Harbour about to be formed on a design by Mr. Parkes, and as the matter is of vital importance to every citizen, especially house-holders, whose property, in the event of failure, cannot, like that of merchants and traders, be removed to a more favored Port or City, I should consider myself culpable were I any longer reticent from a feeling of diffidence as to my powers to handle so difficult a subject, and repugnance to give publicity to my opinions.

I should indeed be the last to oppose an undertaking which, if successful, would undoubtedly enhance the value of the several landed properties which I hold in Madras,—such a proceeding would be counter to my own interest,—so it is not probable I would publish this protest, were I not convinced that there are reasonable grounds for doing so. Being interested in the project, I was induced to study the plan of Harbour, and not being altogether without local experience after a residence of more than 30 years, and not entirely devoid of knowledge on Engineering matters after a service of about 22 years under the Madras Railway Company and Public Works Department, I was enabled to form an opinion which, I regret to say, is not at all favorable to the plan, for in every delineation of it I fail to read anything but Disaster! and Ruin!! to our good old City. This being my conviction, I consider it nothing but my duty to submit the matter to my fellow-citizens; and should these statements be considered worthy their attention, it is left to them to pursue whatever course they may consider necessary to avert the evils threatened. Feeling that possibly a wrong view may be taken by me, I submitted my opinions to the judgment of gentlemen whose

knowledge on nautical matters, and local experience relating to the peculiarities of this coast is unquestionable, and the result was that they concurred with me on every point put forward in this paper. Feeling myself thus supported in my views, I submit them with greater confidence to the public.

I may state, in conclusion, that I was informed by good authority, that experienced Mariners frequenting this coast, declare that rather than risk their vessels being ground to pieces in a harbour which provides no shelter from the force of the wind during a hurricane, they would clear cut and take their chance in the open sea when warned of the approach of one.

From the latter statement, together with others made to me, I would infer that by publishing these papers, I am but expressing a general opinion regarding the close Harbour proposed for Madras.

ROBT. JOHN BALDREY.

RITHERDON ROAD,
EGMORE, 23*rd Novr.*, 1875.

Notes on the Proposed Harbour for Madras on the Plan designed by Mr. Parkes—its defects pointed out and remedies suggested.

INTRODUCTION.

PRIOR to the execution of a gigantic project, such as the harbour scheme for Madras, the success or failure of which would act either beneficially or prejudicially to the Port, it is considered highly desirable, with reference to the proposed project, to obtain all the local experience possible by inviting the residents, whose interest it is to aid, to contribute their mite of information to the general stock. By such a procedure, much light will be thrown on the subject and from quarters where little was expected to be elicited.

This precaution is yet the more necessary, when able and scientific men hold opinions of a conflicting nature regarding the proposed project, and judging from the various reports on the subject, the question as to the practicability of carrying out a work which would provide suitable accommodation and shelter to shipping in the Madras Roads appears to be a case in point, and it would be unreasonable to ignore any information which may help to attain the desideratum coveted, simply because it did not emanate from the source considered to be orthodox. Any particulars, therefore, bearing on the subject, should not be discarded, however humble the source from which it may be drawn, but be impartially weighed and investigated, and thus the path leading to a successful termination will be cleared of all doubts and difficulties.

In the event of Mr. Parkes' plan being carried out, the evils apprehended are particularized as follows:—

1st. Inundation of the Town.

2nd. Unsuitability and consequent failure as to the object for which it is built.

3rd. Productive of sickness.

4th. Faulty construction and imminent destruction.

I shall therefore divide my subject under the following heads:—

Physical, Nautical, Sanitary and Construction, concluding with my suggestions as to how the defects may be remedied.

I shall now proceed to analyze the several heads of my subject, which does not pretend to anything more than an earnest appeal to that rather rare gift, vulgarly designated "sound common sense."

1st. *Physical.*—The features of the Coast of Madras is familiar to my readers, and it will be plain to all, that on such a bold, straight, and low-lying coast with strong litoral currents, any solid pier or arm projecting a considerable distance into the sea at right angles to the line of coast will naturally arrest the progress of the litoral currents, and the obstructed body of water will rise considerably at the point of interception, especially during the periods of strong litoral currents produced by storms during the North-East and South-West monsoons; the direction of either of these winds will force the waves into the north or south angle caused by the projection of the pier from the coast, and drive the waters literally into a corner and cause them to overleap the low bulwark and rush into the town, carrying everything before it, and the disaster which lately befel Masulipatam be re-enacted.

From its lowness, Madras is subject at any time to such a catastrophe, and any measure having a tendency to precipitate its occurrence, should be avoided. I may here quote from Talboys Wheeler's "Madras in the Olden Time," page 128, extract from original records. "The sea having for about ten days past encroached upon this town, and we hoping as it is usual, that it would retreat again of itself, forebore any remedies to keep it off; but now that instead of its losing, mightily gains ground upon us, and that without a speedy course be taken the town will run an apparent hazard of being swallowed up, for it has undermined even to the very wall, and so deep that it has eaten away below the very foundation of the town—and the great bulwark next to the sea side, without a speedy and timely prevention, will certainly in a day or two more, yield to its violence: it is therefore ordered forthwith that the drum be beat to call all coolies, carpenters, smiths, peons and all other workmen, and that sufficient materials be provided, that they work day and night to endeavour to put a stop to its fury;

"for without effectual means be used in such an eminent dan-
"ger and exigency, the Town, Garrison, and our own lives, con-
"sidering all the foregoing circumstances, must needs be very
"hazardous and insecure." Then from a "General Letter," from England, "We take notice of the great inundation that endan-
"gered our Town and Fort, and we would have you endeavour
"to prevent such future accidents * * * * by raising new works
"as a security to their lives, houses, wives and children, and of
"all that belongs to them." I have myself witnessed in ordinary weather a wave break over De Haviland's bulwark or sea wall, and sweep its way past the base of the light-house. Such being the case under ordinary circumstances, with the natural and unaltered line of coast, what may not be expected should an obstructing medium be interposed to the natural course of an impetuous current.

Mr. Parkes' Project just offers such an obstruction; the two arms or piers which he proposes to project several thousands of feet into the sea at right angles to the line of coast presents an opposing body to the storm currents in their natural and straight course along the shore. It is, to say the least of it, very unwise to court danger, and that reason alone should be a sufficient objection against the adoption of any plan which is likely to cause loss to life and property, especially when its ostensible object is to effect the very reverse—as far as I have been able to ascertain, the possibility of inundating the Town from the effects of solid piers, projecting into the sea, has not been as yet considered by the authorities.

The storm currents on this coast are prodigious in force and rapidity. I am well assured of this, for I have been several times an eye-witness to their effects. I have watched the hardy Madras boatman (than whom as a class I have not seen more venturesome and expert swimmers) whilst endeavouring to convey a line to a vessel about to be stranded on the coast, on one occasion somewhere between the Public Works' Workshop and the Ice House, when he was borne rapidly away in a few minutes by the strong current, notwithstanding all his eel-like endeavours to gain the shore, which he only reached somewhere between the bar and cupid's bow, a distance of about a mile and a half. To get to the vessel he had to proceed a considerable distance south in order to drop down on her, which he did, for he had admirably calculated his distance, and had scarcely time to cast the line on board when he was swept past the vessel. This

simple circumstance only serves to show that much is to be feared from any abrupt projection from the line of coast. It may be argued that inundation of the town may be effectually guarded against by erecting a sea wall of sufficient height, to a considerable distance on each side of the harbour to protect the low-lying districts, but is this a contingency that is allowed for in the estimate? if not, the great additional cost would, I consider, be a serious objection, especially when a design precluding any fear of inundation can be provided.

Such an objection cannot be charged against a work like the proposed breakwater, for, being detached from the shore the water cannot be pent up to cause inundation to the town, for it admits of a free passage to the currents between the work and the beach; from a detached work like this, shoaling connot be apprehended: this is the opinion of Sir Arthur Cotton and others (vide Mr. Parkes' report) for the simple reason that the currents along the coast will drive out or scour the sand from between the outwork and the beach, especially if the outwork or breakwater lying parellel to the coast is not of very considerable length, the reductive power on the waves and current flowing into passage between breakwater and shore being proportionate to the length of passage with the squares of its relative width.

On the other hand, it is admitted by all authorities, Mr. Parkes himself included, (vide his report paras. 14 and 15) that piers or groynes extending from the shore will arrest the drift sand; the proposed harbour, therefore, being nothing more than two piers or groynes—which, after running out a considerable distance from the beach into the sea, converge and almost meet; the space between the extremities forming the entrance to the enclosed area intended to shelter vessels—these piers will undoubtedly arrest the sand, but not to the extent supposed by Mr. Parkes, viz., a triangular space, two sides of which will be formed by the pier and shore; for such a mass of sand will not be deposited, owing to the scooping action of the strong litoral currents sweeping the sands along with it round the pier wall of harbour, and on its passage to meet the shore again, deposit the greater portion in the mouth of the harbour, choking it up; this is instanced in several cases where piers have been used. Cressy describing Newhaven and the piers forming it, says "this harbour, *like others on the south coast*, is "greatly affected by the accumulation of beach and shingle

"which cannot be effectually scoured or washed away by "any means yet attempted, notwithstanding the great in- "draught and eddy tide which set towards the mouth, the ave- "rage rise of spring-tide at the harbour's mouth being 19 to 20 "feet, and of neaps about 14 to 15 feet." Such being the case with harbours, possessing the great natural advantage of a constant tidal scour, what can be expected in the case of a close harbour at Madras, where there is only an occasional high water of about 3 feet?—Looking nearer home, I shall conclude my remarks regarding the effects produced by groynes or solid pier-walls by quoting from a report to Government by a local authority: "I have" he says, "only to state that according to "our experience and my own personal observation, every groyne "which has been run out from the old sea wall, viz., De Havi- "land's Bulwark, has carried the beach along with it, the longest "groyne being 400 feet in length, and consequently as the shore "has gained on the sea, the line of surf has moved out in pro- "portion, and it is a question yet to be solved, how long this "same natural action of the elements will continue as similar "works are pushed on seaward."

The above statement is by a marine authority whose experience extended over a period of as many years as did that of Mr. Parkes in days.

With all the natural advantages and the protection which the indented coast of Great Britain affords for the formation of close harbours, it is a recorded fact that numbers of far greater capacity than that proposed for Madras suffer severely from shoaling, so much so, that a port on account of it has been abandoned, and the space once occupied by the harbour is now turned over by the ploughshare, for agricultural purposes; yet it is disallowed by Mr. Parkes, except at a very distant date, and therefore considered no element for consideration, that the close harbour for Madras will be affected by shoaling, notwithstanding all the facilities afforded by the bold, straight, unsheltered sweep of coast (entirely dissimilar to any of those of Great Britain) to the passage of litoral currents, bearing, on their unimpeded course, their burthens of drift sand to be deposited as they speed on in the first cavity or indented space which presents itself along the line of coast.

Mr. Parkes fixes the period of the shoaling of his harbour at the remote date of 180 years. I fail to understand how he could have based his calculations, as he states in his

report to have done, on the amount of sand deposited between the groynes during a season; for it is an undoubted fact that the sand is constantly warped round the head of each groyne by the action of the currents (the very fact of the filling in of the centre and those spaces between groynes furthest from the direction of the current proves this); then the sand deposited, say between the first two groynes, will displace an equivalent or be itself borne over to the second space and so on to the last, to be washed out on to the other side of the beach, only to be brought back after a time by the alternate motion of the current. It is this very principle of action which takes place in the process of harbour shoaling and one which I have tried to explain. This alternative warping of the sand over the pier heads of any close harbour connected with the shore at Madras will effectually close up, if not fill it. Mr. Parkes further remarks that the spaces between the groynes were not filled, as if he considered that process of filling was not completed. I have only to say, neither will they ever be, even after the expiration of a thousand years, if the groynes preserve their form so long, with litoral currents, for the scooping or corroding action of the waves will wear away the sand from the one or the other side of the groynes according to the direction of the current, leaving on the lee side a space unoccupied by sand; the head of each groyne or pier will preserve a clean appearance, for the sand is washed round it constantly, and no deposit at the extremity is allowed to take place.

It will be seen by the foregoing that after a certain accumulation of sand has taken place, the quantity of which need not be sufficient to fill in a rectangular space between the groynes, the surplus sand or that portion which the groyne, not being of sufficient length, could not arrest, is constantly borne backwards and forwards over the heads of the groynes by alternating currents. Such being the case, the deposit *during the season* on which Mr. Parkes based his calculation would have been far greater, within the same given time, had the groynes been of greater length so as to retain or catch the surplus travelling sand; this, no doubt, would inevitably have been the case. From the foregoing, I consider that I have shown the fallacy of the data on which Mr. Parkes has based his computation, and is it not now possible, that the evil of shoaling (which would be a death-blow to the object for which the work is to be executed) be much nearer to our doors than he anticipates?

This is not only possible, but very probable, for there are no currents and surf on the face of the globe more industrious in conveying their sandy treasures to and fro, than those on the Madras coast.

To still further satisfy myself as to the fact of the sand being borne round the head of the groynes, I have caused the surface sea water near the head of a groyne to be caught in a vessel, and found on settlement that there was a considerable quantity of sand at the bottom, the amount of silt thus borne round the groynes of course would depend on the agitation of the waters at the time.

It is therefore a matter for serious consideration whether so large a sum as 56½ lakhs of rupees should be expended on a work, the plan of which, as far as I have shown, promises nothing more than disaster by inundation and the defeat of its object by shoaling.

I shall now proceed to view the subject from a nautical point.

2nd, *Nautical.*—Spots sheltered by nature have, as a rule, been selected for harbours, but the Madras roads do not afford the slightest protection from the very winds that are most destructive to her shipping. Even with the most ordinary high winds, danger, it is apprehended, will be experienced by vessels attempting an entrance into a harbour of the form proposed by Mr. Parkes, who in his report states that Mr. Robertson, Harbour Engineer for India, is of opinion that vessels can enter and quit more readily from behind a break-water than through the one entrance of a harbour. This appears to be the general opinion of nautical men frequenting this coast, and who are aware of the heavy seas to which our very unsheltered roadstead is exposed and subject to: I shall quote from several statements made by experienced mariners—Captain J. D. Gaby of steam ship "*Khiva*," says: "The force of the sea against the pier heads" (of the proposed harbour) "with any winds from the Eastward, and the "eddies caused thereby, a vessel would probably lose her steer-"age way, and unless the engines of the steamer or the tug "towing the sailing ship are very sharply worked, she would "most likely get damaged against the pier or else run into a "ship lying at the buoys before she would recover herself."

From Captain J. H. Atkinson, Superintendent, British India Steam Navigation Company, Calcutta. "The currents would

"at times run strongly across the harbour mouth, and good "judgment with local knowledge would be required to avoid "being set on to either pier head, as, having to bring up, in "a comparatively short distance, the slow rate of speed neces- "sarily maintained, would give time for considerable drift, the "current acting on the length of the vessel." * * * "That the "advantage to be derived from two mouths is, that they would "probably afford a more certain exit from the port, should the "action of a cyclone storm wave cause damages to the sea "wall, and by that or other means drift debris which might "close entrance."

"From Captain T. Black, Superintendent, Peninsular and "Oriental Steam Navigation Company, Southampton. The majority "of those I have consulted and with whom I myself coincide, think "that a long breakwater would be more suitable of the two, "(enclosed harbour and breakwater), the idea being fostered more "by the nautical than the commercial aspect of the question. * * * * "Vessels arriving or putting to sea would also be able to do "so with greater facility behind a breakwater than going in or "out of a close harbour. To the mail steamer of this Com- "pany we think a close harbour, such as Mr. Parkes advocates, "would necessitate a certain amount of risk while entering at "night, small of course if there were light and the water "smooth, but considerable with a strong wind and a high sea, "and the difficulty of bringing up a long steamer in the com- "paratively small area which Mr. Parkes' plan shows, would "be great supposing that a moderate number of ships were "already at anchor inside and the steamer were obliged to "enter with a good way on her to secure steerage. * * * I "think great weight should be attached to Captain Dalrymple's "remarks, that during a gale a ship could run in under the lee "of breakwater for shelter from the heavy sea, while she could "not run into such a harbour as that proposed by Mr. "Parkes, and that in such a harbour the heavy sea would roll in "and the ships in the confined space grind themselves to pieces, "being in a much worse position than an open roadstead. In "point of fact, Captain Dalrymple, Master Attendant at Madras, "evidently thinks that a close harbour *at Madras* would be most "dangerous in cases when shelter would be most required; and "I personally am greatly inclined to coincide with him." Mr. Parkes himself acknowledges in para. 31 of his report, "I "have no hesitation in saying that a roadstead exposed to the

"most prevalent and strongest winds, even irrespective of the "direction of the heaviest seas, cannot be considered to be effec- "tually sheltered."

The foregoing statements need no comment from me; they speak for themselves and are to the point. No harbour in Madras with one entrance, and that facing East by South, will be accessible during the preponderating high winds from the North-east.

3rd, *Sanitary.*—Under this head the effects which will be produced by a close harbour at Madras will now be considered.

It is always thought to be a matter of the greatest importance to adopt necessary measures for the effectual scouring or washing out of harbours, to rid them not only of silt, but of the accumulated filth from shipping &c. The indraught and ebby tides (which are considerable in most harbours, those of Rye harbour being 23 feet spring tide and 14 feet neap) and tidal rivers, are taken full advantage of to effect this great desideratum, for without such means a harbour would be soon rendered useless, and would further prove a source of pestilence,—in fact, the plague-spot of the Port. Subsequent to my consideration of this material point my views were corroborated by the following statement by Captain J. H. Taylor, R. N. R.—"The land- "ing place at Colombo, though having the advantage of a weak "scour, is pestiferous from the mere decomposition of the spilt "grain cargoes and general accumulation of matter." Captain W. Stewart, commanding steam ship "*Indus*," writes:—"There "is one point to which no reference is made, viz., what will be "the sanitary state of such a closed harbour? I suppose, if "necessary, some opening could be left to ensure all accumula- "tion of impurities being carried off by prevailing currents."

This important point appears to be entirely omitted in Mr. Parkes' plan, and, as it is argued by him when describing the reductive power of his harbour, that a wave 10 feet in height outside the harbour will be reduced to a wavelet 1 foot 9 inches on its entrance into it, no scour then can be obtained from such a source, and the only effect which it is expected to produce will be the deposition of everything abominable on the shore within the harbour; and in the event of the harbour's mouth being closed up with sand, the effects of stagnation, together with the accumulated impurities, will render it under a

tropical sun, in reality the plague-spot of Madras, to remove which extraordinary measures, at an enormous cost, will have to be resorted to. Serious inconvenience will not at first be experienced, but after a few years the accumulation of filth, owing to the small rise and fall of the sea, will soon make itself apparent, and discerned by more senses than one. This state of things would be highly objectionable, when it is considered that the harbour will be contiguous to the most thickly-inhabited part of the city, Black Town.

Those who resided in the Fort some few years ago, will not easily forget the overwhelming stench which evolved from a ship, with a cargo of rice, that was stranded somewhat North of the Fort; it was simply so abominable, that it at once awoke the proper authorities to unwonted energy, and the decomposing grain was bundled helter skelter and committed to the "oozy deep," and if I remember rightly, one or two of the coolies died whilst clearing the vessel. Residents who were present on the above occasion will be able to form some idea of the nuisance described by Captain Taylor regarding the landing place at Colombo. I have frequently noticed grain washed along the shore which probably was lost during transmission to and from shipping; this, if not cleared away by the current but enclosed instead in an almost stagnant pool, would, with other matter, in the space of a few years convert the harbour into a large cess-pool. It is evident from the foregoing that it is very necessary to so design a harbour as to allow of its being effectually scoured by the means which nature offers; such can be effected, and I shall endeavour to explain in its proper place, how it can be carried out without additional cost.

The "Silvery Cooum," although having the advantage of being flushed out by freshes once or twice during the year, yet exhales effluvia at times, during the dry season, the most noxious and life-poisoning. What will then be the condition of a close harbour after the lapse of a few years without any such advantage? The cost of diverting the sewers from emptying themselves into the close harbour is also another item which will necessitate a considerable outlay; this can also be avoided by an arrangement which I shall suggest. The objection to a close harbour for Madras, from a sanitary point of view, is serious, and should be sufficient to arrest the attention of the authorities, for what advantage would it be, supposing even that the

harbour afforded all the security to the shipping which is expected from such a work, if the inhabitants of a thickly populated city, and particularly those located in the leading Mercantile houses in Madras, situated on the North Beach, were subjected, by their close proximity, to the baneful effects of impure atmosphere generated by the nuisance described.

4th. *Construction.*—From long observation of the progressive settlement of the boulders of stone used in the construction of the groynes on the beach, and from the gradual disappearance of immense quantities thrown into the roadstead by Captain, now Sir Arthur Cotton, with a view to the formation of a breakwater,* I am led to the conclusion that stones loosely precipitated into the sea, with no cementing agency to bind or connect the stone or rubble into a compact mass, will, in the course of time, be scattered by ground swells and currents, and individually gravitate and be lost in the sand. Such being the inference I have drawn, I am of opinion that the loose rubble intended to be deposited to form a base, on which it is proposed to erect the concrete-block wall of Mr. Parkes' harbour, will effect anything but a solid foundation for the intended superstructure. This is the more forcibly conveyed to the mind when it is considered that the pier or sea-wall proposed for Madras is precisely on the same principle of construction as that just completed for the harbour at Kurrachee, and which has already given way.

Remedies proposed.—In preparing a design for a suitable harbour for Madras, I have kept in view the objections to both the close harbour project and that of the breakwater, and endeavoured to keep clear of the defects or doubtful points of each, selecting the unobjectionable or good characteristics which both possess, and which, if combined, would, I feel confident, afford suitable shelter to the shipping in the Madras Roads, and thus avoid all the dangers apprehended from the adoption of either the close harbour by Mr. Parkes or the breakwater.

In the preparation of my plan, I have avoided the introduction of any construction having its origin at, and projecting from, the shore, in order that sand may not be conducted or borne by the currents from the beach along its extent into

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* This mound of stone was many years ago so near to the surface that it was considered dangerous to shipping, and buoys had to be moored about it to indicate the spot. It is said that very little of the once great heap is at present to be seen.

the harbour and thus shoal it up, and further that there will be no possibility of inundating the town, by avoiding the interposition of an arm from the shore, extending several thousands of feet into the sea. Taking advantage of the currents and adapting them to that end, I have secured a sufficient scour or circulation of the water to keep the harbour free from impurities and consequent danger to public health. The openings which will admit the necessary scour, will at the same time provide a double entrance to the harbour, a point considered to be of great importance by nautical men. By this arrangement easy ingress and egress is also secured without any loss in mooring space, as in the case of Mr. Parkes' arrangement consequent on position of entrance.

The form of harbour which I suggest, will, by shutting out the sea on the North, East and South sides, protect shipping from the heavy seas from the North-east, East, and South-west directions, well known to be most destructive to shipping,—provision is also made to protect the shipping from strong winds. In rough weather it will afford ample mooring space for twenty ships, and in fair weather double that number; whereas in that of Mr. Parkes' plan, only thirteen at any time can be accommodated; this is done without any additional cost, for the length of the sea-wall which I propose is only 8,000 feet, whilst that of Mr. Parkes is, including the shore extensions, 10,000 feet. If it is proposed to accommodate only 13 ships as in Mr. Parkes' plan, a considerable reduction will be effected, and that too on the more expensive principle of construction which he has adopted.

Reporting the capacity of his harbour, Mr. Parkes says, "If the ships were more closely moored, so as to swing clear "of the next ship's mooring, but not of the entire circle she "would describe in swinging, the number would be increased "three-fold," a calculation which will make the capacity of the suggested form of harbour 120 vessels in fair and 60 in foul weather.

The cheapest cementing body I can think of to bind the rubble, is good stiff clay, which can be obtained in abundance, and at an exceedingly low cost. The non-percolating and adhesive qualities of clay are well known. This mixed with the rubble in a proportion that would be sufficient to fill in the interstices of the stones, and, in the course of deposition, held together in large coarse sacks, would, thus deposited, form a

mass, that will, I feel assured, become the more compact by settlement, a result which cannot be expected under similar circumstances from a concrete structure.

The average dimensions of sea-wall proposed by me are as follows:—

Perpendicular, 50 feet, which will carry it 8 feet above high sea level.

Base, 120 feet, top or platform, 24 feet.

These measurements will give a natural slope of 45 degrees on each side.

The core will be of laterite rubble, one-fourth of the bulk of which will be composed of stiff clay to fill up the interstices and bind the work together.

The core thus formed will be preserved from the corrosive action of waves and currents by a casing of granite boulders, 6 feet in thickness over the whole mass.

Such a massive structure would present a more effectual bulwark to the buffetings of storm waves, than would be offered by the more expensive but less massive one, proposed to be carried out by means of concrete blocks.

The wall proposed by me will be 8,000 feet in length; so the total bulk, according to the foregoing section, will be 1,096,296 cubic yards; the component parts of which are to be

Rubble.. ..	611,556 cubic yards	@ Rs.	2-8-0*	Rs.	15,28,890
Clay.. ..	203,852 „	@ „	0-8-0	„	1,01,926
Granite boulders	280,888 „	@ „	4-0-0	„	11,23,552
Total bulk..	1,096,296 cubic yards.		Total	Rs.	27,54,368

leaving a balance sum of Rs. 28,95,632 out of the sum sanctioned for Mr. Parkes' harbour, to be expended in providing shelter to the shipping from winds, extension of present screw pile pier, plant, coarse sacks, establishment, contingencies, &c.

The piles intended for the extension of the present screw pile pier can be employed during construction of the sea-wall for the purposes of a jetty to convey material from the

* The rate at which the harbour works is at present supplied with laterite rubble from the quarries at Ambatoor is, inclusive of Railway charges, about Rs. 2 to 2-8 per cubic yard deposited into the sea.

beach opposite the Railway station at Royapooram to the northern extremity of the proposed sea-wall, from which point the work can be commenced.

Further details regarding labor need not here be entered into, nor do they require description as they are well understood.

The objections to a close harbour for Madras are serious in the extreme, and at best to use the words of a local Marine authority, "the success of an enclosed harbour for "Madras is supposed by numbers to be an impossibility; at all "events it must be problematical." As for the breakwater, unless it extended a considerable distance parallel to the line of coast, (which could only be effected at an enormous cost), it would be of no practical use, for the vessels would be driven from their moorings by storm currents of a north-easterly or south-westerly direction. This is obviated by the large area enclosed by my form of harbour, the force of a storm current would be dissipated by having to spread over such a considerable extent of sheltered space, and a wholesome scour will be the favorable result. This reductive power will be most advantageous for boats, for they may ply at any season, if there is even any necessity for it, for as it can be seen by reference to the plan, the pier is proposed to be extended to the most favorable point to enable shipping to lay to for the purposes of loading and unloading.

I consulted a Government Marine Authority as to the distance vessels could approach the shore with safety; he considered that a vessel could approach to about five-hundred feet off the pier; this is a distance of 1,500 feet from shore, but I have allowed 2,500 feet from the shore to the terminal points of the proposed sea-wall, thus giving ample space for egress and ingress to vessels in any weather. This distance from the shore is the more favourable as there is no shifting sand beyond this point the bed of the sea there being clay. (Vide statement of Government Diver, Break-water Committee's Report.)

Summary.—The form of harbour I propose will then avoid

Inundation of the Town.
Shoaling.
Additional ill-health to the city.

Disaster to vessels from insufficient entrance and from want of shelter from strong winds and exposure to heavy seas from the east.

Advantages to be derived by the adoption of the form of harbour proposed by me.

Mooring space.—Considerably more area is provided for mooring vessels, probably all that will ever be required, and at less cost than that proposed by Mr. Parkes.

Scour.—A sufficient scour or washing out of the harbour is obtained by the passage of the currents through the two openings intended for entrances.

Two entrances.—An advantage considered of great importance by nautical men.

Protection to shipping.—Great storm waves from the East run dead on shore and are considered the most dangerous to shipping; it has been therefore a matter for particular consideration to provide against such a contingency, which is effected by entirely shutting out the heavy seas from that direction.

Ready conversion into a close harbour should there be any necessity for it.—This can at any time be effected by continuing and joining the North and South walls with the shore, whereas in the event of Mr. Parkes' harbour proving a failure, the possibility of converting it into any other form will be precluded by the extension of his walls from the shore.

Cheapness.—A harbour of far less cost than that proposed by Mr. Parkes can be carried out, even if constructed with the expensive materials he proposes, if accommodation equivalent to that provided by him is only required.

Future extension.—Should this ever be required, it could be carried out by constructing only two sides either to the North or South of the proposed harbour.

In conclusion, I trust I have given an intelligible form to my ideas on this subject, and by cautiously steering clear of the strong objections to a Breakwater or close harbour as unadapted to the requirements and peculiarities of this coast and combining the good points in each, I have realised a form of harbour suitable for Madras.