(1) பக்கங்களின் எண்ணிக்கை 34

(2) புதுக்கித் திருப்பிய நாள் மார்ச் 1991

(3) ஆதாரங்குறிப்பவர் சுருக்கொப்பம்

தமிழ்நாடு ஆவணக் காப்பகம்.

தமிழ்நாடு அரசு

பொதுப்பணித் துறை

அரசாணை எண். / மு. கோப்புத் தாள் எண். 821 W

அச்சகம் / பலவகை

நாள் : 24.8.1893 198 .

மடிக்கவோ கண்டபடி கையாளவோ கூடாது

ஆவண. கா-1—18,006—15-6-87.

24th March 1893, No. 821 W., Public Works.

GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

Buildings and Roads.
Civil Works.

Read—the following paper :—

> Despatch from the Right Honorable Her Majesty's Secretary of State for India, to His Excellency the Right Honorable the Governor in Council, Fort St. George, dated India Office, London, 23rd February 1893, No. 2 (Public Works).

In reviewing the progress report of the Madras Harbour for the quarter ending 31st December 1891, attention was drawn by Sir A. Rendel to the destructive action of the salts contained in sea water on cement concrete and it was suggested that a new specification for the cement used in the Madras Harbour works was desirable.

2. I forward, for the information of your Government, copy of Sir A. Rendel's report, dated 22nd April 1892, together with a copy of the revised specification which has been finally agreed upon.

Enclosures.

Copy report by Consulting Engineer, dated 22nd April 1892.

The progress made during the last quarter of 1891 appears to have been very small. The solid superstructure of the south pier was advanced by only 6¼ lineal feet and no addition was made to that of the north pier. Some wave-breaker blocks were, according to the plan showing the work of the quarter, thrown outside the ends of both piers; but, according to the quarterly statement, they were only thrown on the outside of the north pier and were only 29 in all. The top of the rubble base on which the superstructure of the north pier rests was protected on its inner side by a paving of concrete for a length of 215 feet. 239 cubic yards of concrete, I presume in blocks, were made and 21,443 tons of stone were received from the quarries at Pallávaram, of which 19,617 tons were deposited in the bank which is formed along the shore north of the harbour for its protection from erosion.

No cement was received into store during the quarter and only about 30 tons were issued, the result being that there were in store at the end of the quarter the large quantity of 2,100 tons. As cement deteriorates by long keeping, it seems desirable that further supplies should be so arranged as to prevent so great an accumulation.

The total expenditure on the works during the quarter appears to have been Rs. 62,296, but we are not told if this includes "establishment."

As the permanence of cement concrete exposed to the action of sea water has been lately brought into question on very serious grounds, I think it well to mention here that I have just reported to the Public Works Loan Board upon the failure of an important concrete breakwater at Mevagissey on the south coast of Cornwall for which they found the money (£20,000). It was built during the years 1889 and 1890 and was destroyed by a heavy gale in the spring of 1891. Mr. Arnold Philip, late the chemist employed at Coopers Hill on chemical investigations connected with Indian State Railways materials, who undertook for me the chemical inquiry which the case seemed to me to require, has clearly showed in a report (copy of which I append) that one sufficient cause (there were others) for the failure was the destructive action which the salts contained in sea water had had on the Portland cement which had been used in the construction of the breakwater and there can be now I think no doubt that this action has to be taken into account in all works of the same class. Fortunately the way to avoid it is now clear also. It is to make the concrete so watertight that water cannot easily pass into and out of it. The danger is of course least where the tidal rise and fall is, as at Madras, very small, because in such cases the alternations of water-pressure on the concrete, first inwards and then outwards, are too small to overcome the frictional resistance which concrete of fair solidity offers to the passage of water through it. Why the salts do not attack the faces of concrete has not I think been yet made quite clear, but we know by experience that they do not do so. Even at Mevagissey I found the faces, which were made of much stronger and closer concrete than the interior, so sound and hard that I did not think it necessary to have them even analysed. The destructive action was apparently confined to the weaker interior, the sea water finding free access to it under tidal pressure through the bottom of the breakwater which was founded on gravel or coarse sand, the result being that 30 per cent. of the lime contained in the cement used at the level of low water had disappeared in less than three years.

In order to make concrete sufficiently watertight we must use plenty of sand, and, as a consequence, plenty of cement. I should put the safe proportions for it at three of small broken stone, two of sand and one of cement, to which may be added, say, not more than half a ton of large stones to every yard of concrete, and even at Madras I think these proportions should be used in any concrete that has yet to be made. A new specification for the cement is also desirable in which its specific gravity should be substituted for weight per bushel. According to recent experiments the specific gravity should be 3·1 and power to make chemical analysis and reject upon it if necessary should also be taken.

REMARKS on the results of the analytical examination of the two samples of *damaged concrete* reported on 30th March 1892.

The damage which sea water causes to concrete is due to the interaction which takes place between the silicate of lime, of which the Portland cement is chiefly composed, and the sulphate and chloride of magnesia contained in the sea water. A double decomposition takes place in which hydrated sulphate of lime is formed, silica is set free, and magnesium hydrate is deposited, whilst probably some chloride and sulphate of lime is dissolved out in the water. The destructive result of this chemical action must be considered under two heads:—

First when it takes place in the interior of a mass of concrete. Owing to the porosity of concrete of the strength commonly employed in modern works (mixtures of one part of cement with from 8 to 10 parts of sand and stones are frequently used and rubble is often added) if its face is unprotected by any denser and more impervious material and if it is subjected to varying pressures due to tides, wave action, &c, a more or less rapid flow of sea water takes place through its pores.

The origin of the tensile strength of Portland cement after setting is the felting or matting together of the thousands of crystals which are formed as the freshly mixed cement combines chemically with the water with which it is gauged; this is what is meant by the setting of the cement.

The chemical action of the sea water destroys this source of strength in two ways. Firstly by actually dissolving and weakening the individual crystals in this felted mass and secondly by the bursting or blowing action caused by the fresh crystallisation of one of the products of the chemical action, viz, the sulphate of lime; as this crystallises out it absorbs water, with which it chemically combines, increases in volume and mechanically breaks up and tears apart the felted crystals of the cement, hence destroying its internal cohesion. It may be readily imagined that damage of this character proceeds with an accelerating velocity, for the disintegration caused permits the flowing water to carry off the broken down and powdered material, thus leaving still larger openings for a fresh influx of water.

To prevent this action of sea water upon the internal portions of concrete masses, the outside surfaces have been faced with a fine dense cement plaster or concrete containing a much larger proportion of the Portland cement than the underlying concrete. This device has acted very successfully in protecting the concrete and this necessitates the consideration of the action of sea water under the second condition, namely when it can only act on the exterior of the mass.

As the exterior of a mass of concrete is exposed to the direct action of the sea and as the wash of the waves and the scour of the tide must be always supplying fresh quantities of water, it might be supposed that the exterior of the concrete would be more rapidly acted upon than the interior, where, even if the concrete has very considerable porosity, the flow of the damaging water is comparatively slow. Moreover as the exterior or protecting surface, as has already been pointed out, contains much more cement than the interior of the mass, one might suppose that, as it is the cement which is acted upon and not the sand and stone, such protecting faces would be rapidly corroded away and the interior concrete soon become exposed to the sea.

Experiment, however, has constantly shown that this is not the case and this difference is probably due to the fact that the chemical action takes place only at the surface and there is therefore no bursting action due to crystallisation of the decomposition products; hence there is none of that mechanical disintegrating action which takes place when the same chemical decompositions take place in the interior of the mass, and, moreover, as the products of the decomposition of the cement, due to the first attack of the sea water upon the external face, crystallise out, they form a protecting surface to the cement, rendering it more impervious to the chemical action of the sea water and also by mechanically choking the pores the soaking in of the decomposing salts is stopped. In order to show more clearly the extent to which chemical alteration has taken place in the two samples of concrete in question the following table has been drawn up:—

Table showing the alteration in chemical composition of two samples of concrete from Mevagissey Harbour, caused by sea water [samples were marked, respectively, "*(a)*" and "*(b)*"].

—	1 *(a)*. Results of analysis of the concrete "*(a)*."	2 *(a)*. Actual composition of the altered cement in "*(a)*" calculated from column 1 *(a)*.	3 *(a)*. Probable composition of the original cement used in concrete "*(a)*" [deducted from column 1 *(a)*].	1 *(b)*. Results of analysis of concrete "*(b)*."	2 *(b)*. Actual composition of the cement in "*(b)*" calculated from column 1 *(b)*.	3 *(b)*. Probable composition of the original cement used in concrete "*(b)*" [deducted from column 1 *(b)*].
Combined water and Carbonic acid ..	11·890	..	..	13·380	..	1·000
Sand	48·340	0·000	1·000	45·650	0·000	23·350
Soluble silica (S_1O_2)	8·190	20·326	21·523	48·960	21·318	1·500
Sulphuric acid (SO_3)	4·267	10·591	1·500	4·762	11·330	..
Alumina (Al_2O_3)	..	..	..	..	..	..
Ferric oxide (Fe_2O_3)	5·210	12·930	13·691	4·590	10·921	11·595
Lime (CaO)	17·390	43·159	60·927	19·870	47·276	60·839
Magnesia (MO)	4·142	10·279	1·500	2·482	5·954	1·500
Chloride (Cl)	1·093	2·712	0·000	1·365	3·247	0·000
Total ..	100·522	99·997	100·141	101·059	100·046	99·784

The columns marked 1 *(a)* and 1 *(b)* show the results of the actual analysis of the concrete separating as completely as possible the sand and stones from the cement. In the columns marked 2*(a)* and 2*(b)*, the results have been calculated from the results in columns 1*(a)* and 1*(b)* after deducting the sand, the combined water, and the carbonic acid, and these columns show the extent to which the composition of the original cement has been altered, that is on the assumption that the original cement used was one of normal composition and satisfactory in character, and in columns 3*(a)* and 3*(b)* are given what in all probability were the constituent parts of these cements. These results have been calculated from the analytical results given in columns 1*(a)* and 1*(b)*. As will be readily seen the alteration is very considerable and chiefly consists in an increase in the amounts of magnesia and sulphuric acid and a diminution in the amount of lime present, no doubt due to the action of the sea water, whilst the quantity of silica and aluminium and iron oxides remain practically unaltered. The decomposed cements also contain a notable proportion of chlorine when element is absent from normal cement and must have been derived from the sea water.

(Signed) ARNOLD PHILIP.

NOTE by Sir A. M. Rendel.

The sample *(a)* was taken from the base of that portion of the south breakwater which was destroyed by the gale of the 9th March 1891 at about the level of low water of ordinary spring tides

The sample *(b)* was taken from the parapet of the north breakwater. It was taken from the concrete immediately underlying the surface at a point where the surface had disappeared not far from the inner end of the breakwater.

SPECIFICATION of Portland cement.

The cement is to be of the best quality and of such a density that when a week old the specific gravity shall not be less than 3·1.

The cement must be made entirely from well-burned clinker ground to such a degree of fineness that the whole will pass through a sieve made of wire ·007" diameter having 2,500 meshes per square inch and that 90 per cent. by weight of the whole will pass through a sieve made of wire ·005″ diameter containing 5,776 meshes per square inch in each case without rubbing. No powder or imperfectly burned material is to be ground up with the clinker.

Samples of the cement will be taken at the contractor's works as often as may be deemed necessary. From these samples test briquettes will be gauged and moulded and placed in fresh water 24 hours after gauging and will remain under water till tested. The water used in gauging the cement is not to be less than 20 per cent. (by weight) of the cement.

After six days' immersion the briquette will be subjected in a machine to a tensional strain applied at the rate of 100 lb. in 25 seconds of not less than 400 lb. on a section of one square inch and after 13 days' immersion to a tensile strain similarly applied of not less than 450 lb. per square inch. Three briquettes are to be tested for each test and the average of these to be taken as the tensile strain.

The colour of the briquettes at their fracture after testing must be dark slate blue throughout.

Pats $\frac{7}{8}$ inch thick, gauged as above, are not to show any cracks or alterations of form whether left in the air or under water, and, when broken, must be uniform in colour and hardness throughout the section.

On analysis the cement must be found to contain not more than 61·5°/o lime, 1·25°/o magnesia, sulphides and sulphates equivalent to 1·75°/o sulphuric acid and not less than 23°/o silica and 12°/o alumina and oxide of iron.

Cement which does not stand the above tests will be rejected.

Order—dated 24th March 1893, No. 821 W., Public Works.

Communicated to the Chairman, Harbour Trust Board, for information and guidance.

(True Extract.)

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

To the Chairman, Harbour Trust Board.
„ the Marine Department.
„ Superintending Engineers.
„ the Consulting Architect to Government.
„ the Superintendent of Works, Periyár Project.
„ the Chief Engineer for Irrigation.
„ the Consulting Engineer for Railways.

Exd. A. D. Xavier.
Spare Copies

BUILDINGS AND ROADS.
CIVIL WORKS.

Govt. of {1893} Madras.

PUBLIC WORKS.

Dated March, 24th.

Recd. *Encl.*

G.O., 24th Mar. 1893, No. 821 W.

MARCH.

Portland Cement Concrete

Despatch from the Secretary of State forwarding, for information, copy of Sir A. Rendel's report on the action of sea water on —, together with a copy of a revised specification, communicated to the Chairman, Harbour Trust Board, for information and guidance.

2655

This question of the action of sea water on Portland Cement Concrete – and the proposed revised tests for the cement are I think of sufficient interest to render it desirable + to issue the order to this Dept. generally

AWW
20/3/93

821 W

+ [illegible]
21/3/93

D.W.

Please see "communications" added to the draft order.

R.S.
21.III.93.

Seen
AWW
21/3

821 W

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INDIA OFFICE
LONDON, 23rd FEBRUARY, 1893.

Public Works,
No. 2.

TO HIS EXCELLENCY THE RIGHT HONOURABLE THE GOVERNOR IN COUNCIL, FORT ST. GEORGE.

My Lord,

In reviewing the Progress Report of the Madras Harbour for the quarter ending 31st December 1891, attention was drawn by Sir A. Rendel to the destructive action of the salts contained in sea water on cement concret and it was suggested that a new specification for the cement used in the Madras Harbour Works was desirable.

2. I forward for the information of your Government copy of Sir A. Rendel's report dated 22nd April 1892, together with a copy of the revised specificatio which has been finally agreed upon.

I have, &c.,
(Sd.) Kimberley.

Duple

OW 2655/93

No 2.

Public Works

23rd February /93

Copy Letters to Fort St. George

No 2

G.O. 821 W.
24/3/93

P1

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2/82

INDIA OFFICE,
LONDON, 23rd FEBRUARY, 1893.

Public Works,
No. 2.

TO HIS EXCELLENCY THE RIGHT HONOURABLE THE GOVERNOR
IN COUNCIL, FORT ST. GEORGE.

My Lord,

In reviewing the Progress Report of the Madras Harbour for the quarter ending 31st December 1891, attention was drawn by Sir A. Rendel to the destructive action of the salts contained in sea water on cement concrete, and it was suggested that a new specification for the cement used in the Madras Harbour Works was desirable.

2. I forward for the information of your Government copy of Sir A. Rendel's report dated 22nd April 1892, together with a copy of the revised specification which has been finally agreed upon.

I have the honour to be,
My Lord ,
Your Lordship's most obedient humble Servant,

Kimberley

P. W. CURRENT No. 2655

No. 6

Public Works.

23rd February / 93.

The Letter to Fort St. George

No. 2.

Encls. 5

Recd: 20.3.93

No. 1885 E 9-4-92
" 15/2777 W - 10-11-91
" 2999-3000 W. 10-11-91
" 528 E - 2-2-92
" 430 W - 12-2-92
" 950-W - 22-3-92

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Encl. 1/21 SP-2

COPY REPORT BY CONSULTING ENGINEER, DATED 22nd APRIL, 1892.

The progress made during the last quarter of 1891 appears to have been very small. The solid superstructure of the South Pier was advanced by only 6¼ lineal feet, and no addition was made to that of the North Pier. Some wave-breaker blocks were, according to the plan shewing the work of the quarter thrown outside the ends of both Piers; but, according to the quarterly statement, they were only thrown on the outside of the North Pier, and were only 29 in.all. The top of the rubble base on which the superstructure of the North Pier rests, was protected on its inner side by a paving of concrete for a length of 215 feet-239 cubic yards of concrete. I presume in blocks- were made, and 21,443 tons of stone were received from the quarries at Pallavaram, of which 19,617 tons were deposited in the bank which is formed along the shore north of the Harbour for its protection from erosion.

No cement was received into store during the quarter and only about 30 tons were issued, the result being that there were in store at the end of the quarter the large quantity of 2,100 tons. As cement deteriorates by long keeping, it seems desirable that further supplies should be so arranged as to prevent so great an accumulation.

The total expenditure on the works during the quarter appears to have been Rs.62,296, but we are not told if this includes "Establishment ".

As the permanence of cement concrete exposed to the action of sea water has been lately brought into question on very serious grounds, I think it well to mention here that I have just reported to the Public Works Loan Board upon gravel or coarse sand, the result being that 30 per cent of the lime contained in the cement used at the level of low water had disappeared in less than three years.

In order to make concrete sufficiently watertight we must use plenty of sand, and as a consequence, plenty of cement. I should put the safe proportions for it at three of small broken stone, two of sand and one of cement, to which may be added say not more than half a ton of large stones to every yard of concrete, and even at Madras I think these proportions should be used in any concrete that has yet to be made. A new specification for the cement is also desirable in which its specific gravity should be substituted for weight per bushel. According to recent experiments the specific gravity should be 3·1. and power to make chemical analysis and reject upon it if necessary should also be taken.

9/21 SP-5

REMARKS on the results of The Analytical Examination of the two samples of DAMAGED CONCRETE reported on March 30th 1892.

The damage which sea water causes to concrete is due to the interaction which takes place between the Silicate of lime of which the Portland Cement is chiefly composed, and the Sulphate, and Chloride of magnesia contained in the sea-water. A double decomposition takes place in which hydrated Sulphate of lime is formed, Silica is set free, and Magnesiam hydrate is deposited, whilst probably some Chloride and sulphate of lime is dissolved out in the water. The destructive result of this chemical action must be considered under two heads :-

First when it takes place in the interior of a mass of concrete. Owing to the porosity of concrete of the strength commonly employed in modern works /mixtures of one part of cement, with from 8, to 10 parts of sand and stones are frequently used and rubble is often added/ if its face is unprotected by any denser, and more impervious material,and and if it is subjected to varying pressures due to tides, wave action &c. a more or less rapid flow of sea-water takes place through its pores.

The origin of the tensile strength of Portland cement after setting is the felting, or matting together of the thousands of crystals which are formed as the freshly mixed cement combines chemically with the water with which it is gauged; this is what is meant by the setting of the cement.

The chemical action of the sea water destroys this source of strength in two ways. Firstly by actually dissolving, and weakening the individual crystals in this felted mass, and secondly by the bursting, or blowing action caused by the fresh crystallisation of one of the products of

9.5 [illegible] 5.3/93

10/22 S.P.6

of the chemical action viz. the sulphate of lime; as this crystallises out it absorbs water, with which it chemically combines, increases in volume and mechanically breaks up and tears apart the felted crystals of the cement, hence destroying its internal cohesion. It may be readily imagined that damage of this character proceeds with an accelerating velocity, for the disintegration caused permits the flowing water to carry off the broken down and powdered material, thus leaving still larger openings for a fresh influx of water.

To prevent this action of sea water upon the internal portions of concrete masses, the outside surfaces have been faced with a fine dense cement plaster, or concrete containing a much larger proportion of the Portland cement than the underlying concrete. This device has acted very successfully in protecting the concrete, and this necessitates the consideration of the action of sea water under the second condition namely when it can only act on the exterior of the mass.

As the exterior of a mass of Concrete Is exposed to the direct action of the sea, and as the wash of the waves and the scour of the tide must be always supplying fresh quantities of water, it might be supposed that the exterior of the concrete would be more rapidly acted upon than the interior, where, even if the Concrete has very considerable porosity the flow of the damaging water is comparatively slow. Moreover as the exterior or protecting surface, as has already been pointed out, contains much more cement than the interior of the mass, one might suppose that, as it is the cement which is acted upon and not the sand and stone, such protecting faces would be rapidly corroded away and the interior concrete soon become exposed to the sea.

Experiment

11/821 S.P. 4

Experiment, however has constantly shewn that this is not the case, and this difference is probably due to the fact that the chemical action takes place only at the surface and there is therefore no bursting action due to crystallisation of the decomposition products; hence there is none of that mechanical disintegrating action, which takes place when the same chemical decompositions take place in the interior of the mass, and moreover, as the products of the decomposition of the cement, due to the first attack of the sea water upon the exterhal face, crystallise out they form a protecting surface to the cement, rendering it more impervious to the chemical action of the sea water, and also by mechanically choking the pores the soaking in of the decomposing salts is stopped. In order to shew more clearly the extent to which chemical alteration hastaken place in the two samples of concrete in question the following table has been drawn up.

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3657/47

TABLE SHOWING THE ALTERATION IN CHEMICAL COMPOSITION OF TWO SAMPLES OF CONCRETE FROM MEVAGISSEY HARBOUR, CAUSED BY SEA WATER, /SAMPLES WERE MARKED RESPECTIVELY "A" AND "B".

	1. A.	2. A.	3. A.	1. B.	2. B.	3. B.
	Results of analysis of the Concrete "A".	Actual composition of the altered cement in "A". Calculated from Col. 1.A.	Probable composition of the original cement used in Concrete "A" /deducted from Col. 1.A./	Results of analysis of Concrete "B".	Actual composition of the cement in "B" calculated from Column 1. B.	Probable composition of the original cement used in concrete "B"/deducted from Column 1. B.
Combined water & carbonic acid	11.890			13.380		
Sand	45.340	0.000	1.000	45.550	0.000	1.000
Soluble Silica /S_1O_2/	8.190	20.326	21.523	48.960	21.318	23.350
Sulphuric Acid /SO_3/	4.267	10.591	1.500	4.762	11.330	1.500
Alumina /Al_2O_3"						
Ferric Oxide /Fe_2O_3/	5.210	12.930	13.691	4.590	10.921	11.595
Lime /CaO/	17.390	43.159	60.927	19.870	47.276	60.839
Magnesia /MgO/	4.142	10.279	1.500	2.482	5.954	1.500
Chlorine /Cl/	1.093	2.712	0.000	1.365	3.247	0.000
	100.522	99.997	100.141	101.059	100.046	99.784

13

9

PW 8.2
2655/35

118 SP-10

SPECIFICATION OF PORTLAND CEMENT.

The cement is to be of the best quality and of such density that when a week old the specific gravity shall not be less than 3·1.

The cement must be made entirely from well burned clinker ground to such a degree of fineness that the whole will pass through a sieve made of wire ·007" diameter having 2500 meshes per square inch, and that 90 per cent. by weight of the whole will pass through a sieve made of wire ·005" diameter containing 5776 meshes per square inch in each case without rubbing. No powder or imperfectly burned material is to be ground up with the clinker.

Samples of the cement will be taken at the Contractor's works as often as may be deemed necessary. From these samples test briquettes will be gauged and moulded and placed in fresh water 24 hours after gauging and will remain under water till tested. The water used in gauging the cement is not to be less than 20 per cent (by weight) of the cement.

After six days immersion the briquette will be subjected, in a machine, to a tensional strain, applied at the rate of 100 lbs. in 25 seconds, of not less than 400 lbs. on a section of one square inch and after 13 days immersion to a tensile strain similarly applied of not less than 450 lbs. per square inch. Three briquettes are to be tested for each test and the average of these to be taken as the tensile strain.

The colour of the briquettes at their fracture after testing must be dark slate blue throughout.

Pats 7/8 inch thick, gauged as above, are not to show

any

SP-11

any cracks or alterations of form whether left in the air or under water, and when broken must be uniform in colour and hardness throughout the section.

On analysis the cement must be found to contain no more than 61·5% lime, 1·25% magnesia, sulphides and sulphates equivalent to 1·75% sulphuric acid and not less than 23% silica and 12% alumina and oxide of iron.

Cement which does not stand the above tests will be rejected.

No. 821 W. d/24th March 1893

PUBLIC WORKS DEPARTMENT.

PROCEEDINGS OF THE MADRAS GOVERNMENT.

READ the following

Despatch from the Secretary of State for India H.E. No. 2 Public Works d/23rd Feby:/93.

P. 12

Communicated to the Chairman Harbour Trust Board for information and guidance.

Mo 23 Mar

Pr. 21/3/93

20.3.93

Chairman H. T. Board

Marine Dept.

Supdg. Engr.

C.A. to Govt.

Secy. P.W.

C. Engr. I.

C. Engr. Rys.

D. 10/4

C No. 2655

1893.

Public Works Department.

No. 831 W

Dated 24 March/93.

Despatched

Received

C. 27/3

SUBJECT.

Portland cement concrete

=

Des: from the Secy: of State forwarding for information copy of Sir A. Rendel's report on the action of seawater on ——— together with a copy of a revised specifn.

commd. to the Chairman H.C.B. for information and guidance

3/2/3