THE UNIVERSITY OF NEW SOUTH WALES

BUILDING RESEARCH CENTRE
The Faculty of the Built Environment

INVESTIGATION OF CONCRETE SLABS MODIFIED WITH XYPEX WATER-PROOFING ADMIXTURE

FOR

XYPEX AUSTRALIA

INVESTIGATION OF CONCRETE SLABS MODIFIED WITH XYPEX WATER-PROOFING ADMIXTURE

INTRODUCTION

Don Veness of Xypex Australia asked the Building Research Centre (BRC) to investigate the condition of precast concrete jetty planks that had been used at the Cronulla Marina, and hence to draw conclusions about the performance of the materials used.

The precast panels were cast in October 1994 and Xypex C-2000 had been added to the concrete mix to enhance the water-proof characteristics of the concrete. The slab top surface had been treated with a "Faux Brick" application to form a pattern textured concrete surface for decorative purposes. The design details of the concrete mix and the slabs, the test results of compressive strength and chloride contents in the aggregates are attached in Appendix I. The slab has been exposed to what would be described as a severe marine environment similar to a "splash zone" since construction as the slab top surface is only about 350 mm above sea level.

To assess the performance of the materials, samples were taken from the outermost jetty plank, the one which is most exposed to wind swept waves from the South and South West and a halfcell potential survey was conducted on the leading portion of the plank.

SITE INVESTIGATION

An inspection of a selected deck slab (see Appendix I for location and details of the slab) in Cronulla Marina was undertaken in November 1998 by BRC staff in the presence of Neil Jones from Xypex Australia.

The prestressed concrete deck slab inspected is 100 mm thick, 1.2-m wide and about 12-m long.

It was observed during the visual inspection that there were no defects on the slab. The concrete slab can be described as sound and in a good condition without cracks or rust stains. The concrete cover to the main prestressing strands was measured with a Covermeter and found to be in a range of 40 to 45 mm. This was confirmed at one location by drilling a hole to a strand.

A set of four concrete powder samples was extracted by drilling six holes from the slab top surface. These were at the depths of 5-15, 15-25, 25-35, and 35-45mm. The sampling sites on the slab top surface were selected at the joints between the Faux Brick patterns to avoid the influence of the Faux Brick on chloride penetration into the concrete. The first 0-5mm surface concrete layer at each drilling site was discarded to eliminate the influence of any possible surface contamination.

A reference concrete powder sample was also taken from a spare slab made from the same batch of concrete at the time but stored inland without exposure to the marine environment. This concrete powder sample was analyzed to assess the background chloride ion content in the concrete.

To facilitate a half-cell potential test of part of the slab top surface, the electrical continuity between the prestressing strands was evaluated. The longitudinal strands in the middle and near one edge of the slab were located with a Covermeter and two holes were drilled and direct connections to the strands were made. A third hole was drilled to expose a transverse reinforcing bar. The measurements of the electrical resistance between the exposed two prestressing strands and the mild steel transverse bar indicated that they all electrically continuous with an electrical resistance of 0.2 ohms.

An area over the full width of the slab (1.2-m) and 3-m long in the mid of the slab top surface was marked with grid size of 150x150-mm and a half-cell potential survey was conducted at each of the grid intersections. A copper/copper sulphate half-cell was used and the connection to the reinforcing steel was made to one of the exposed strands.

ANALYSIS AND DISCUSSION

The five concrete powder samples were analyzed for chloride ion contents and then the results were used for the analysis of the chloride diffusion coefficient. The half-cell potential test results were further analyzed for equal-potential contours. These results are presented and discussed as follows.

Chloride Ion Contents and Chloride Diffusion Coefficient

The chloride ion contents by weight of cement at different depths are as shown in the following Table-1.

Table-1. Chloride Ion Contents in the Concrete Slab

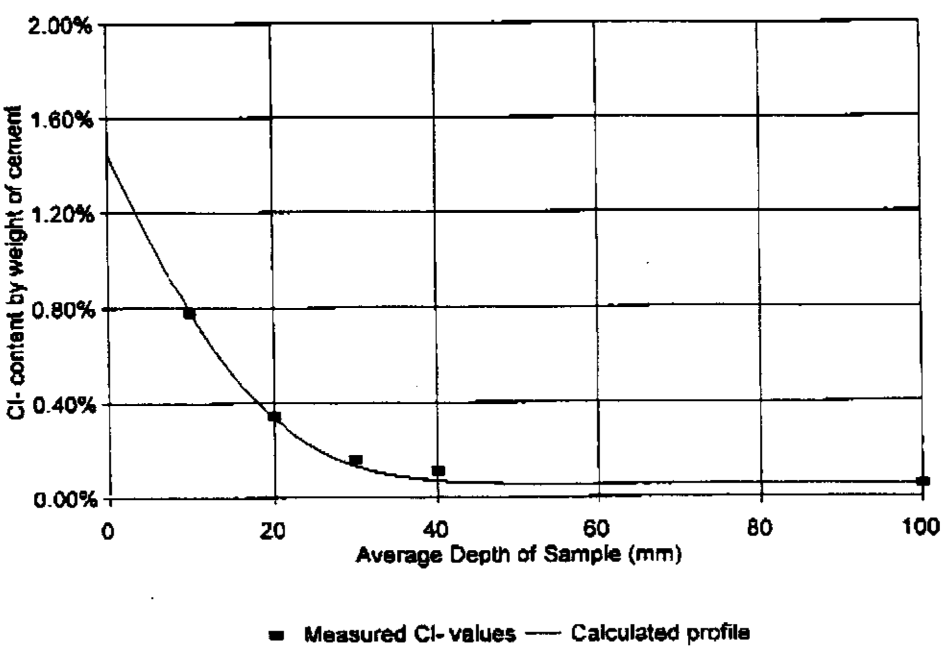
Range of Sample Depths (mm)	Average Sample Depth (mm)	Chloride Ion Content by Weight of Concrete (%)	Chloride Ion Content by Weight of Cement (%)
5 - 15	10	0.182	0.78
15 – 25	20	0.080	0.35
25 – 35	30	0.037	0.16
35 – 45	40	0.026	0.11
Background	Background	0.013	0.06

In the Australian standard AS-3600 (Clause 4.9.1), the maximum acid-soluble chloride ion content in prestressed concrete as placed is limited to 0.8 kg/m^3. The chloride ion content in the background concrete converts to 0.3 kg/m^3, which is well below the allowed value of AS-3600.

After four years exposure in a severe marine environment at the splash zone, the chloride ion content in the slab is relatively low compared to that in many normal concrete elements. The chloride concentration also drops significantly with increase in depth.

To further evaluate the resistance of the concrete to chloride penetration, the chloride contents in Table-1 along the slab depth are plotted in Fig-1 as the square points. In this plot the background concrete is assumed at 100 mm, a depth where the external ingress of chlorides can be ignored. The curve in Fig-1 is the best-fitting curve of a theoretical analysis of the chloride content profile based on Fick's second law of diffusion. An effective chloride diffusion coefficient of 9.7 $\times 10^{-13}$ (m^2/s) is calculated from the theoretical curve. This is a low value compared to that measured on most normal concretes.

Fig-1. Chloride Diffusion Profile



Based on the 90-day chloride ponding test (AASHTO T-259) results, Andrade and Whiting [1] reported chloride diffusion coefficients of 3.13×10^{-12}, 1.82×10^{-12} and 1.51×10^{-12} (m^2/s) for three concretes with w/c ratio of 0.60, 0.40 and 0.32 respectively. The chloride diffusion coefficients of these three concretes are 3.27, 1.88 and 1.56 times higher than that of the Xypex modified concrete in this investigation.

It was also found by the BRC in a two-year old marine concrete structure above the splash zone that the chloride diffusion coefficients were in the range of 1.45×10^{-12} (m^2/s) to 2.24×10^{-12} (m^2/s), which are 1.5 to 2.3 times of that in the slab of this investigation.

Half-Cell Potential Survey

The half-cell potential technique has been widely used in corrosion condition survey since the report of the work on the evaluation of the condition of bridge decks by J R Van Daveer in 1975. This US Federal Highway Administration project compared the results of potential surveys to the physical manifestation of corrosion on reinforcing steel on 473 bridge decks. On the basis of this work Van Daveer and his team recommended guidelines for the probability of corrosion for varying potential readings as set out below.

- If a potential reading is more negative than -350 millivolt, then there is a 90% probability that the steel is corroding.
- Between -200 and -350 millivolts there is a 50% chance that the steel is corroding.
- If a potential reading is less negative than -200 millivolt then there is a 90% chance that the steel is not corroding.

This work became the basis of the ASTM C876-91 standard and the above guidelines were also included in the appendix to ASTM C876 as a non-mandatory information.

However, these interpretation criteria were devised empirically based on structures affected by deicing salts. Care must be taken if interpretations are made on potential readings measured on other types of structures under different environmental conditions.

It has been found that, for different concretes and in different environmental conditions, the potential ranges can shift significantly [2]. In marine environments, very negative potential readings can be found in saturated conditions. However, the corrosion rates in these cases are often so slow as to be negligible due to the lack of oxygen for the cathodic reactions of the corrosion process. Therefore, the location of steel corrosion in different structures can not be generally based on the criteria given in the Appendix of ASTM C876-91 [2]. The interpretation of the potential data, especially in marine structures, has to be based on the correlation with the actual corrosion condition of exposed rebars and the experience in investigation of similar corrosion problems.

The further analysis of half-cell potential readings on the basis of local gradient of potential change is considered to be a better way to identify corroding rebars. Although there are no general criteria for assessment, a guideline is that active corrosion sites may be characterised by potential gradients exceed 150mV per meter.

In this investigation, a copper/copper-sulphate half-cell (Borin, USA) was used for the potential survey. The potentials are measured on 150-mm square grids over an area on the slab top surface of 3-m long and the whole width (1.2-m) of the slab. The half-cell potential results are shown in Table-2 and the potential gradients along the direction of the main reinforcement (X-axis) are also analyzed and included in the table. The potential results were further analyzed and plotted as a potential contour map in Fig.-2, which shows equal-potential lines with a 10-mV difference between the lines. The potential gradient values at all grid points were also sorted, from the maximum to the minimum, and given in Table-3.

Fig-2. Half-Cell Potential Contour Map over 3-m Length of the Deck Slab

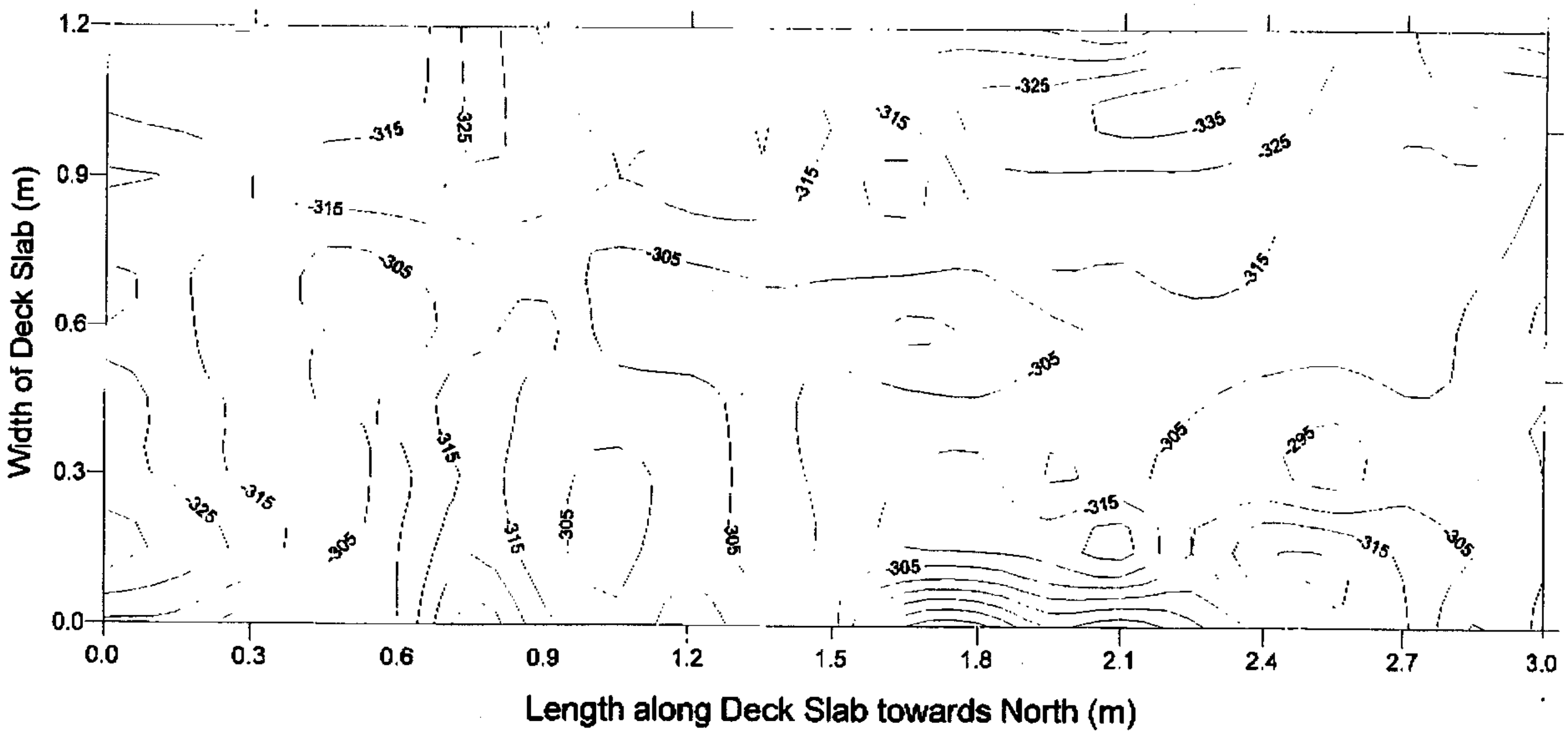


TABLE-2: HALF CELL POTENTIAL VALUES ON SLAB TOP SURFACE

2-1

X-Direction (Slab Length) (m)	Y-Direction (Slab Width) (m)	Half-cell Potential (mV)	Potential Gradient (mV/m)	X-Direction (Slab Length) (m)	Y-Direction (Slab Width) (m)	Half-cell Potential (mV)	Potential Gradient (mV/m)
0	0	-313	7	2.55	0.3	-291	13
0.15	0	-312	47	2.7	0.3	-302	20
0.3	0	-299	57	2.85	0.3	-297	10
0.45	0	-295	20	3	0.3	-305	53
0.6	0	-305	157	0	0.45	-335	107
0.75	0	-342	43	0.15	0.45	-319	73
0.9	0	-318	117	0.3	0.45	-313	50
1.05	0	-307	10	0.45	0.45	-304	20
1.2	0	-321	7	0.6	0.45	-307	60
1.35	0	-309	40	0.75	0.45	-322	10
1.5	0	-309	180	0.9	0.45	-310	37
1.65	0	-255	193	1.05	0.45	-311	0
1.8	0	-251	70	1.2	0.45	-310	33
1.95	0	-276	53	1.35	0.45	-301	0
2.1	0	-267	20	1.5	0.45	-310	23
2.25	0	-282	107	1.65	0.45	-308	13
2.4	0	-299	140	1.8	0.45	-308	7
2.55	0	-324	60	1.95	0.45	-310	27
2.7	0	-317	100	2.1	0.45	-314	13
2.85	0	-294	30	2.25	0.45	-306	40
3	0	-308	93	2.4	0.45	-302	27
0	0.15	-341	67	2.55	0.45	-298	7
0.15	0.15	-331	63	2.7	0.45	-304	20
0.3	0.15	-322	80	2.85	0.45	-304	3
0.45	0.15	-307	57	3	0.45	-305	7
0.6	0.15	-305	57	0	0.6	-315	13
0.75	0.15	-324	10	0.15	0.6	-317	30
0.9	0.15	-308	73	0.3	0.6	-306	40
1.05	0.15	-302	13	0.45	0.6	-305	20
1.2	0.15	-312	3	0.6	0.6	-300	20
1.35	0.15	-301	17	0.75	0.6	-311	60
1.5	0.15	-307	43	0.9	0.6	-318	43
1.65	0.15	-314	27	1.05	0.6	-298	73
1.8	0.15	-315	17	1.2	0.6	-296	17
1.95	0.15	-319	47	1.35	0.6	-303	13
2.1	0.15	-329	47	1.5	0.6	-300	33
2.25	0.15	-305	17	1.65	0.6	-293	10
2.4	0.15	-324	63	1.8	0.6	-297	33
2.55	0.15	-324	37	1.95	0.6	-303	33
2.7	0.15	-313	63	2.1	0.6	-307	20
2.85	0.15	-305	30	2.25	0.6	-309	10
3	0.15	-304	7	2.4	0.6	-310	3
0	0.3	-327	27	2.55	0.6	-310	7
0.15	0.3	-323	50	2.7	0.6	-312	27
0.3	0.3	-312	40	2.85	0.6	-302	63
0.45	0.3	-311	30	3	0.6	-293	60
0.6	0.3	-303	20	0	0.75	-316	0
0.75	0.3	-317	20	0.15	0.75	-316	13
0.9	0.3	-309	53	0.3	0.75	-312	40
1.05	0.3	-301	3	0.45	0.75	-304	17
1.2	0.3	-310	3	0.6	0.75	-307	33
1.35	0.3	-302	7	0.75	0.75	-314	3
1.5	0.3	-308	43	0.9	0.75	-308	33
1.65	0.3	-315	33	1.05	0.75	-304	3
1.8	0.3	-318	37	1.2	0.75	-307	13
1.95	0.3	-304	33	1.35	0.75	-308	3
2.1	0.3	-308	17	1.5	0.75	-308	3
2.25	0.3	-299	33	1.65	0.75	-309	0
2.4	0.3	-298	27	1.8	0.75	-308	30

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Potential Range: -251 mv to -342 mv ; Total Points : 189 Average Potential: -310.5 mv ;

TABLE-2: HALF CELL POTENTIAL VALUES ON SLAB TOP SURFACE

2-2

X-Direction (Slab Length) (m)	Y-Direction (Slab Width) (m)	Half-cell Potential (mV)	Potential Gradient (mV/m)	X-Direction (Slab Length) (m)	Y-Direction (Slab Width) (m)	Half-cell Potential (mV)	Potential Gradient (mV/m)
1.95	0.75	-318	27	1.35	1.2	-307	67
2.1	0.75	-316	17	1.5	1.2	-285	3
2.25	0.75	-323	3	1.65	1.2	-308	80
2.4	0.75	-315	60	1.8	1.2	-309	13
2.55	0.75	-305	13	1.95	1.2	-304	40
2.7	0.75	-311	10	2.1	1.2	-297	70
2.85	0.75	-308	40	2.25	1.2	-325	123
3	0.75	-299	60	2.4	1.2	-334	7
0	0.9	-326	13	2.55	1.2	-327	57
0.15	0.9	-324	37	2.7	1.2	-317	103
0.3	0.9	-315	10	2.85	1.2	-296	103
0.45	0.9	-321	23	3	1.2	-286	67
0.6	0.9	-322	10				
0.75	0.9	-324	0				
0.9	0.9	-322	30				
1.05	0.9	-315	7				
1.2	0.9	-320	27				
1.35	0.9	-323	33				
1.5	0.9	-310	73				
1.65	0.9	-301	37				
1.8	0.9	-321	77				
1.95	0.9	-324	3				
2.1	0.9	-322	3				
2.25	0.9	-323	7				
2.4	0.9	-320	20				
2.55	0.9	-317	27				
2.7	0.9	-312	10				
2.85	0.9	-314	27				
3	0.9	-304	67				
0	1.05	-313	27				
0.15	1.05	-309	20				
0.3	1.05	-307	10				
0.45	1.05	-306	10				
0.6	1.05	-310	70				
0.75	1.05	-327	27				
0.9	1.05	-318	57				
1.05	1.05	-310	13				
1.2	1.05	-314	47				
1.35	1.05	-324	3				
1.5	1.05	-313	17				
1.65	1.05	-319	50				
1.8	1.05	-328	37				
1.95	1.05	-330	37				
2.1	1.05	-339	27				
2.25	1.05	-338	20				
2.4	1.05	-333	57				
2.55	1.05	-321	50				
2.7	1.05	-318	20				
2.85	1.05	-315	13				
3	1.05	-314	7				
0	1.2	-318	27				
0.15	1.2	-314	7				
0.3	1.2	-316	17				
0.45	1.2	-309	27				
0.6	1.2	-308	63				
0.75	1.2	-328	13				
0.9	1.2	-312	70				
1.05	1.2	-307	23				
1.2	1.2	-305	0				

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TABLE-3: SORTED HALF CELL POTENTIAL GRADIENT VALUES

X-Direction (Slab Length) (m)	Y-Direction (Slab Width) (m)	Half-cell Potential (mV)	Potential Gradient (mV/m)	X-Direction (Slab Length) (m)	Y-Direction (Slab Width) (m)	Half-cell Potential (mV)	Potential Gradient (mV/m)
1.65	0	-255	193	1.35	0	-309	40
1.5	0	-309	180	0.3	0.3	-312	40
0.6	0	-305	157	2.25	0.45	-306	40
2.4	0	-299	140	0.3	0.6	-306	40
2.25	1.2	-325	123	0.3	0.75	-312	40
0.9	0	-318	117	2.85	0.75	-308	40
2.25	0	-282	107	1.95	1.2	-304	40
0	0.45	-335	107	2.55	0.15	-324	37
2.7	1.2	-317	103	1.8	0.3	-318	37
2.85	1.2	-296	103	0.9	0.45	-310	37
2.7	0	-317	100	0.15	0.9	-324	37
3	0	-308	93	1.65	0.9	-301	37
0.3	0.15	-322	80	1.8	1.05	-328	37
1.65	1.2	-308	80	1.95	1.05	-330	37
1.8	0.9	-321	77	1.65	0.3	-315	33
0.9	0.15	-308	73	1.95	0.3	-304	33
0.15	0.45	-319	73	2.25	0.3	-299	33
1.05	0.6	-298	73	1.2	0.45	-310	33
1.5	0.9	-310	73	1.5	0.6	-300	33
1.8	0	-251	70	1.8	0.6	-297	33
0.6	1.05	-310	70	1.95	0.6	-303	33
0.9	1.2	-312	70	0.6	0.75	-307	33
2.1	1.2	-297	70	0.9	0.75	-308	33
0	0.15	-341	67	1.35	0.9	-323	33
3	0.9	-304	67	2.85	0	-294	30
1.35	1.2	-307	67	2.85	0.15	-305	30
3	1.2	-286	67	0.45	0.3	-311	30
0.15	0.15	-331	63	0.15	0.6	-317	30
2.4	0.15	-324	63	1.8	0.75	-308	30
2.7	0.15	-313	63	0.9	0.9	-322	30
2.85	0.6	-302	63	1.65	0.15	-314	27
0.6	1.2	-308	63	0	0.3	-327	27
2.55	0	-324	60	2.4	0.3	-298	27
0.6	0.45	-307	60	1.95	0.45	-310	27
0.75	0.6	-311	60	2.4	0.45	-302	27
3	0.6	-293	60	2.7	0.6	-312	27
2.4	0.75	-315	60	1.95	0.75	-318	27
3	0.75	-299	60	1.2	0.9	-320	27
0.3	0	-299	57	2.55	0.9	-317	27
0.45	0.15	-307	57	2.85	0.9	-314	27
0.6	0.15	-305	57	0	1.05	-313	27
0.9	1.05	-318	57	0.75	1.05	-327	27
2.4	1.05	-333	57	2.1	1.05	-339	27
2.55	1.2	-327	57	0	1.2	-318	27
1.95	0	-276	53	0.45	1.2	-309	27
0.9	0.3	-309	53	1.5	0.45	-310	23
3	0.3	-305	53	0.45	0.9	-321	23
0.15	0.3	-323	50	1.05	1.2	-307	23
0.3	0.45	-313	50	0.45	0	-295	20
1.65	1.05	-319	50	2.1	0	-267	20
2.55	1.05	-321	50	0.6	0.3	-303	20
0.15	0	-312	47	0.75	0.3	-317	20
1.95	0.15	-319	47	2.7	0.3	-302	20
2.1	0.15	-329	47	0.45	0.45	-304	20
1.2	1.05	-314	47	2.7	0.45	-304	20
0.75	0	-342	43	0.45	0.6	-305	20
1.5	0.15	-307	43	0.6	0.6	-300	20
1.5	0.3	-308	43	2.1	0.6	-307	20
0.9	0.6	-318	43	2.4	0.9	-320	20

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Potential Gradient: 0 to 193 mv /m; Total Points : 189 Average Potential Gradient: 35.6 mv /m;

TABLE-3: SORTED HALF CELL POTENTIAL GRADIENT VALUES

2-2

X-Direction (Slab Length) (m)	Y-Direction (Slab Width) (m)	Half-cell Potential (mV)	Potential Gradient (mV/m)	X-Direction (Slab Length) (m)	Y-Direction (Slab Width) (m)	Half-cell Potential (mV)	Potential Gradient (mV/m)
0.15	1.05	-309	20	1.5	0.75	-308	3
2.25	1.05	-338	20	2.25	0.75	-323	3
2.7	1.05	-318	20	1.95	0.9	-324	3
1.35	0.15	-301	17	2.1	0.9	-322	3
1.8	0.15	-315	17	1.35	1.05	-324	3
2.25	0.15	-305	17	1.5	1.2	-285	3
2.1	0.3	-308	17	1.05	0.45	-311	0
1.2	0.6	-296	17	1.35	0.45	-301	0
0.45	0.75	-304	17	0	0.75	-316	0
2.1	0.75	-316	17	1.65	0.75	-309	0
1.5	1.05	-313	17	0.75	0.9	-324	0
0.3	1.2	-316	17	1.2	1.2	-305	0
1.05	0.15	-302	13				
2.55	0.3	-291	13				
1.65	0.45	-308	13				
2.1	0.45	-314	13				
0	0.6	-315	13				
1.35	0.6	-303	13				
0.15	0.75	-316	13				
1.2	0.75	-307	13				
2.55	0.75	-305	13				
0	0.9	-326	13				
1.05	1.05	-310	13				
2.85	1.05	-315	13				
0.75	1.2	-328	13				
1.8	1.2	-309	13				
1.05	0	-307	10				
0.75	0.15	-324	10				
2.85	0.3	-297	10				
0.75	0.45	-322	10				
1.65	0.6	-293	10				
2.25	0.6	-309	10				
2.7	0.75	-311	10				
0.3	0.9	-315	10				
0.6	0.9	-322	10				
2.7	0.9	-312	10				
0.3	1.05	-307	10				
0.45	1.05	-306	10				
0	0	-313	7				
1.2	0	-321	7				
3	0.15	-304	7				
1.35	0.3	-302	7				
1.8	0.45	-306	7				
2.55	0.45	-298	7				
3	0.45	-305	7				
2.55	0.6	-310	7				
1.05	0.9	-315	7				
2.25	0.9	-323	7				
3	1.05	-314	7				
0.15	1.2	-314	7				
2.4	1.2	-334	7				
1.2	0.15	-312	3				
1.05	0.3	-301	3				
1.2	0.3	-310	3				
2.85	0.45	-304	3				
2.4	0.6	-310	3				
0.75	0.75	-314	3				
1.05	0.75	-304	3				
1.35	0.75	-308	3				

BRC Ref No: 35918

The potential values measured on the slab top surface are in the range from –251 mV to –342 mV with an average of –310 mV. If judged by the guidelines in the ASTM C876, these locations all fall into the range with a corrosion risk of fifty percent. However, both the range of potential values and the potential contour map indicate a fairly uniform potential distribution over the slab surface. It is shown in Table-3 that there are only three locations where the potential gradient is over 150 mV per metre. These three locations are all at the slab edge (y=0) with the x-coordinate of 0.60, 1.50 and 1.65 m respectively; these locations are also indicated by the denser equal-potential lines in the contour map Fig-2.

It was noted during the visual inspection that there is a narrow plastic strip fixed by galvanized screws along each side and flush with the slab surface. It is likely that some of these fixing screws might have caused the distortion of the half-cell potential gradient at the slab edge. It is observed from Table-3 that the first four locations with the highest potential gradient are all at the slab edge and twelve out of the first fourteen locations are also at the edges.

SUMMARY AND CONCLUSIONS

The condition of a concrete deck slab modified with Xypex water-proofing admixture was examined after four years exposure to the marine environment in the splash zone. It was observed during the visual inspection that the slab was in good condition and free of defects, cracks or rust stains.

Concrete powder samples were taken from the slab at four depths and from a spare slab of the same concrete stored inland, this was used as the reference sample. The results of chemical analyses of these samples indicated that the chloride content in the slab was relatively low and drops rapidly with increase in the slab depth. The effective chloride diffusion coefficient was found to be 9.7×10^{-13} (m^2/s), which is a low value compared to some available results from other laboratory tests and site investigations.

The half-cell potential readings measured on a 3x1.2-m^2 area on the slab top were in the range of –251mV to –342mV. Although the absolute potential values were not low, the potentials were fairly uniform over the slab surface as shown by the potential contour map and the results of potential gradient analyses. Among all the 189 grid locations, only three were found having a potential gradient greater than 150 mV per metre, which may indicate some active corrosion reactions. These three locations are, however, all at the slab edge, where some galvanized screws were used to fix a narrow plastic strip along the slab. It is likely that these screws might have affected the potential gradient at the three locations.

In conclusion, the slab concrete modified with Xypex water-proofing admixture is in a good service condition after a four-year exposure period in a severe marine environment. This is indicated by the defect-free appearance, a low chloride diffusion coefficient and the insignificant half-cell potential gradient over the slab surface.

REFERENCE

1. Andrade, C. and Whiting, D., "Comparison of AASHTO T-277 (electrical) and AASHTO T-259 (90d ponding) Results", Chloride Penetration into Concrete, RILEM Workshop, France, 1995, pp. 135-149.
2. Elsener, B. and Bohni, H., "Potential Mapping and Corrosion of Steel in Concrete", Proceedings of the Symposium on Corrosion Rates of Steel in Concrete, ASTM, 1990, pp143-156.

Appendix I

Design Details of Concrete Mix and Slabs, Test Results of Compressive Strength of Concrete and Chloride Content in Aggregates and Sands

SEA-SLIP MARINAS

DATE: 16/11/98

TO: DON VENESS
XYPEX AUSTRALIA

FROM: Lyn Brighton

SUBJECT: CONCRETE MIX DESIGN used in our precast prestressed marine decks.

CONCRETE DESIGN MIX INCLUDING ADDITIVES

530 KG	G.P. CEMENT	
730 KG	20MM BASALT	(S.C. Latite)
340KG	10MM BASALT	(S.C. Latite)
480KG	COURSE SAND	(Nepean)
120KG	FINE SAND	(Kurnell)
170L	WATER	

SLUMP TO 85-90MM AT PLANT TO ACHIEVE SLUMP 80MM ON SITE FOR POURING

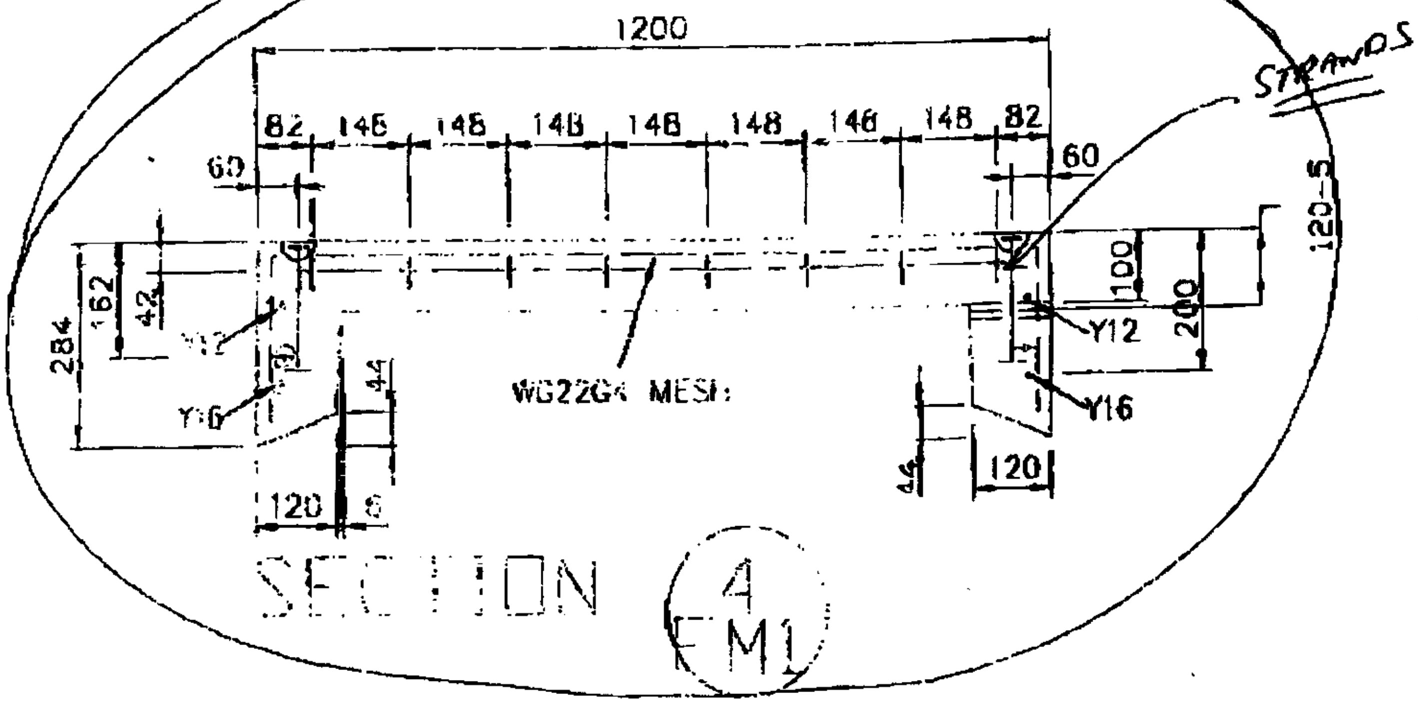
ADMIX – **XYPEX C 2000 4.2KG PER CUBIC METRE**

This batch has been designed to suit our needs to achieve the strength required ie 32 mpa for stripping at about 36-40 hrs. We do not have the steam curing facility. We have with the above batch achieved the required strength in the time, we reach approx. 50mpa in 7 days & around 70mpa in 28 days. We have been using this mix design successfully from the outset in October 1994.

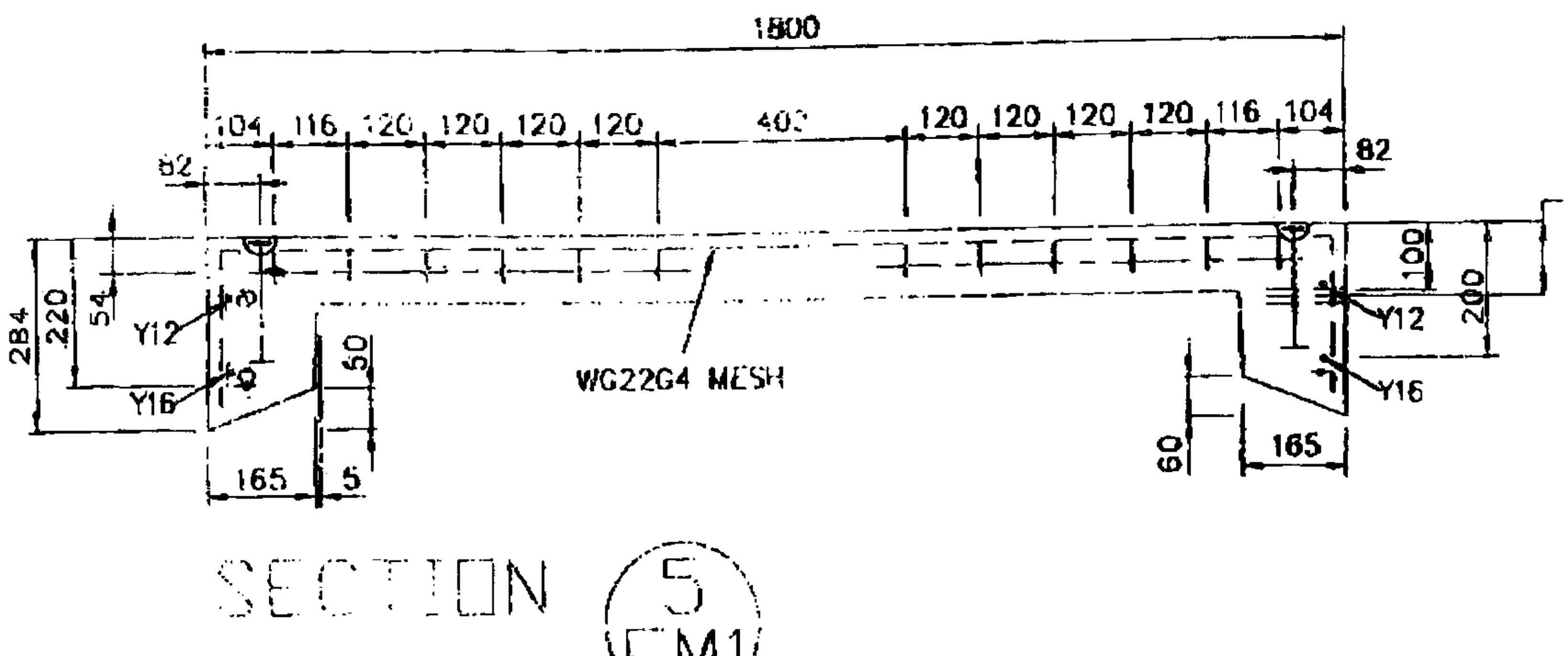
Regards,

Lyn D. Brighton
For Sea-Slip Marinas Pty Ltd

Lyn Brighton



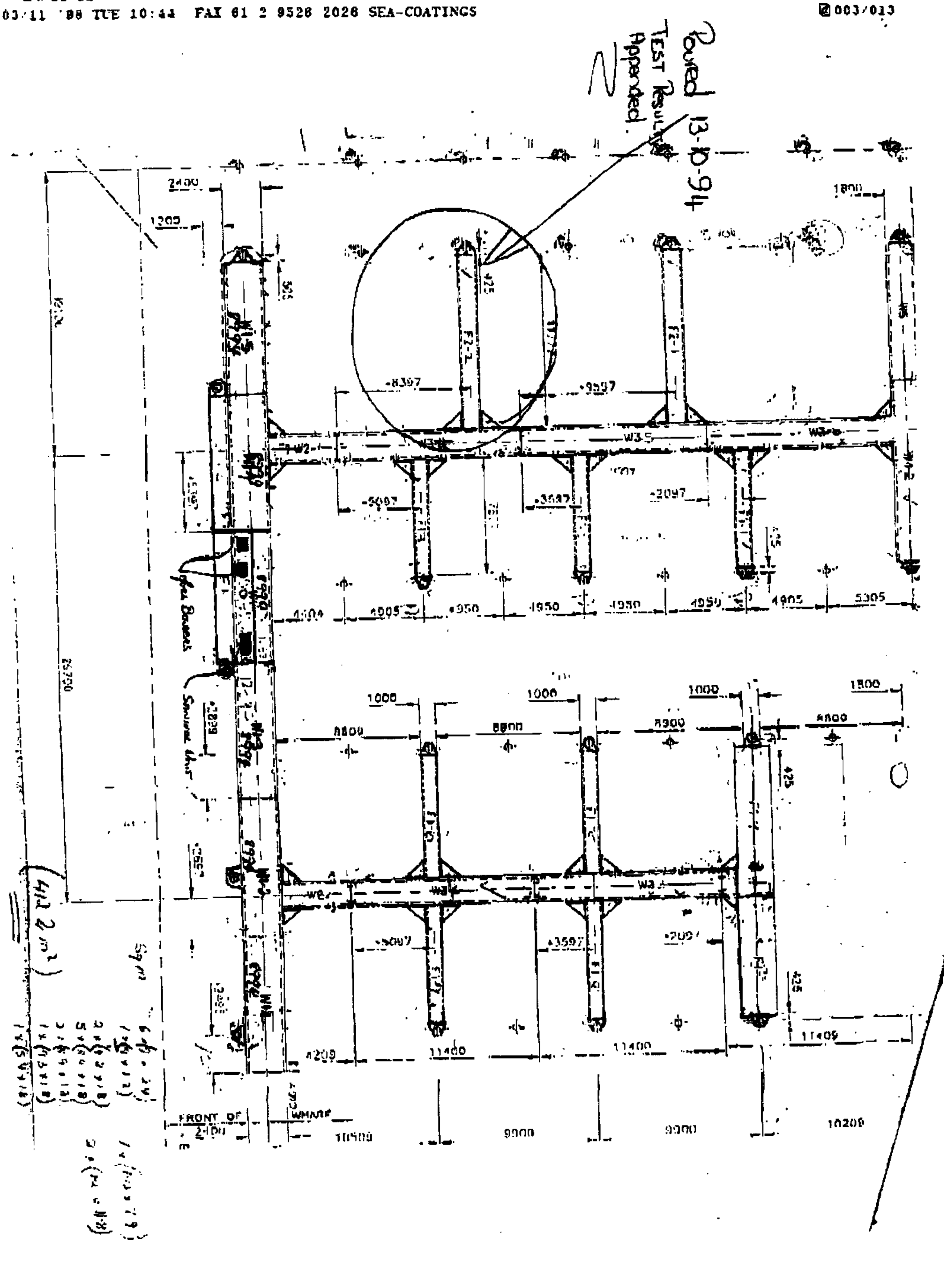
DECK WIDTH	1200mm
No OF STRANDS	10
DIA OF STRANDS	9.3mm / 7 Wire STRAND.
PRESTRESSING	74kN
WEIGHT	386kg/m
CONC BATCH	386kg/m



DECK WIDTH	18
No OF STRANDS	14
DIA OF STRANDS	9..
PRESTRESSING	74
WEIGHT	56
CONC BATCH	56

DECK WIDTH
No OF STRA
DIA OF STRA

15/12/98 10:03 FAX 0293983114 BRC-RANDWICK
98 10:35 XYPEX AUSTRALIA → 61 2 398 3114
TUE 10:44 FAX 61 2 9828 2020 SEA-COATINGS
NO.193 P06
0293983114
015


Poured 13-10-94
TEST Results Appended.
FRONT OF
WHARF
2400
1800
1000
1000
1000
1500
11400
11400
11409
10500
9000
9000
10200

CONTEST CONCRETE TESTING PTY. LTD.
A.C.N. 001 871 067
Telephone: (02) 9601 3422
Fax: (02) 9601 8041
Correspondence: P.O. Box 523, Sutherland, 2232

CONTEST

17/12/98

Xypex Australia Pty Limited
P.O.Box 255
LAVINGTON NSW 2641

Attention: Mr Don Verness

re: Typical chloride content of aggregates.

The typical chloride content of aggregates used as raw materials for concrete supplied by Concrite Pty Limited to the Sea Coatings project at 58-64 Cook street, Kurnell, were as tabled below:

Material	Typical Chloride Content
Latite ex Bass Point	0.02%
Coarse River Sand ex Nepean	0.002%
Fine Dune Sand ex Kurnell	0.003%

Regards

S Pignat.
Stuart Pignat
Laboratory Manager

CONTEST CONCRETE TESTING PTY. LTD
A.C.N. 001 871 067
26 Seton Road, Moorebank.
Telephone: (02) 601 3547
Fax: (02) 601 8041
Correspondence: P.O. Box 126, Miranda. 2228

CONTEST

REPORT ON COMPRESSIVE STRENGTH TESTS OF CONCRETE CYLINDER SPECIMENS

Test Report No.: **940230**
Sydney Laboratory

This laboratory is registered by the National Association of Testing Authorities, Australia. The tests reported herein have been performed in accordance with its terms of registration.

NATA

CLIENT: **SEA COATINGS NSW**
P.O.BOX 233
CARINGBAH NSW 2229

PROJECT: 58-64 COOK STREET, KURNELL.

LOCATION OF POUR: SLAB

DATE OF SUPPLY: 13/10/94

Plant Docket No. Time Batched	Strength Grade Mix Identific. Ordered and Actual slump	Smpl.Loc. Smpl.Proc.	Time Sampled Conc.Temp.(°C) Init.Curing (hrs)	Specimen Ident.	Date of Test	Standard Moisture Curing (days)	Cap Type	aver. diam. x height	Mass per Unit Volume (kg/m^3)	Age at Test (days)	Compressive Strength (MPa)	Remarks
...cation of batch after placement (if avail.)												
CONCRITE-KIR	**50** F'c	6(b)	13:50	10874/A	14/10/94		R	100.0x199	2440	1	25.0	
449325	50 MPa	7.2.1	20	10874/B	15/10/94	1	R	99.8x200	2440	2	38.0	
12:50	80	75	24	10874/C	15/10/94	1	R	100.0x199	2460	2	40.0	
				10874/D	20/10/94	6	S	99.9x202	2480	7	56.0	
				10874/E	10/11/94	27	S	99.9x203	2460	28	68.5	
				10874/F	10/11/94	27	S	99.8x202	2500	28	69.5	
CONCRITE-KIR	**50** F'c	6(b)	13:50	10874/G	15/10/94	1	R	100.0x199	2420	2	35.0	water
449325	50 MPa	7.2.1	20	10874/H	15/10/94	1	R	100.2x200	2420	2	35.5	added
12:50	80	80	24	10874/I	20/10/94	6	R	100.4x198	2440	7	53.5	on site

Additional Information Relating to Tests

4 LITRES SUPERPLASTICIZER ADDED TO MIX.

SPECIMEN "A" CRUSHED AT 24 hours.
"B" CRUSHED AT 42 hours.
"C" CRUSHED AT 46 hours.

"G" CRUSHED AT 42 hours.
"H" CRUSHED AT 46 hours.

Note 1: Tests in accordance with AS 1012 Parts 1, 3 [Method 1], 8, 9 and 12 (Section 1) unless noted otherwise.
Note 2: Sampling location & procedure reference is to clauses in AS 1012 Part 1.
Note 3: All specimens compacted by rodding unless otherwise stated.
Note 4: Standard temperature zone.
Note 6: Cap Types : R = Rubber, S = Sulfur
Note 7: Unless otherwise noted, mass per unit volume of hardened concrete was determined in standard moisture condition, capped if sulfur cap used and uncapped if rubber cap used.

Approved Signatory
Date: 24/11/1994