TECHNICAL REPORT

Title	JINGSLINK MARKETING PTE LTD XYPEX WATERPROOFING SINGAPORE ARTS CENTRE PROJECT
Reference No.	1303/97/8426

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Distribution

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Taywood Engineering Limited	-1

Abstract

Jingslink Marketing Pte Ltd have engaged Taywood Engineering Limited (TEL) to act as an independent third body with expertise in materials consultancy to evaluate the effectiveness of the Xypex product used as an admixture.

This report contains the comments and views of the material.

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TABLES

APPENDICES

1. INTRODUCTION

1.1 Background

Concrete Waterproofing Manufacturing Pty. Ltd. (CWMPL) trading as Xypex Australia have engaged Taywood Engineering Limited (TEL) to act as an independent third body with expertise in materials consultancy to comment on the effectiveness of the Xypex product. Key issues to address which are of interest to PWD are:

- the waterproofing capability of concrete when Xypex is used as an admixture
- heat reduction in concrete when Xypex is used
- increase in compressive strength in concrete when Xypex is used

CWMPL have given the proposed trial methodology (see Appendix A) for TEL to comment. A letter of TEL's comment is given in Appendix B.

Two concrete blocks of 2m by 2m by 0.9m were cast; one with the Xypex admixture and the other as a control. The Xypex treated concrete block was cast on 14 Jan 1997 and the Control mix concrete block was cast on 22 Jan 1997. Both concrete mix designs were given by the Client. The mix with Xypex admixture was designed by CWMPL and the control mix was designed by Supermix Concrete Pte. Ltd. to meet the requirements of Penta Ocean Construction Co., Ltd. in construction of the Singapore Art Centre.

Setsco Services Pte Ltd (SETSCO) carried out the site temperature monitoring and cores sampling for laboratory testing. This report contains TEL assessment of SETSCO's test results and available technical information in order to evaluate the Xypex product.

1.2 Scope of Work

TEL's scope of work included:

a. Review of available technical data sheets, test reports and methodology proposed for evaluating the product.

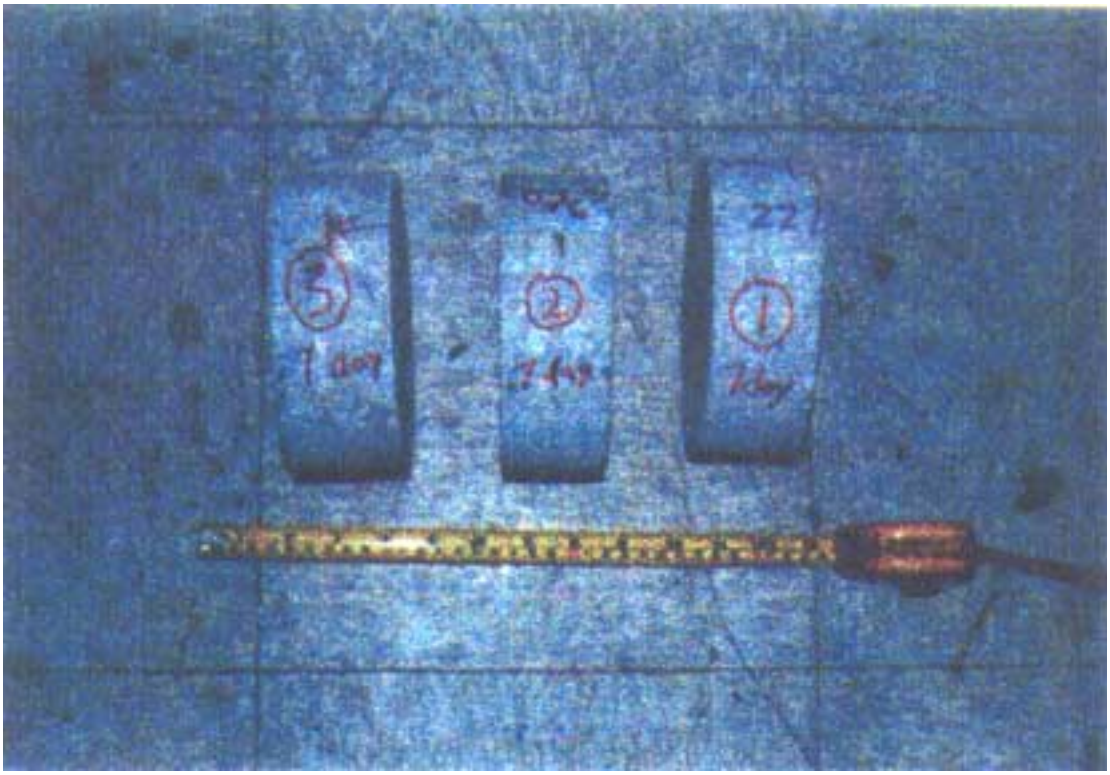
b. Comments based on item (a) above with particular reference to its effects on waterproofing, heat reduction and compressive strength.

c. Issuing of a report containing the results of the evaluation.

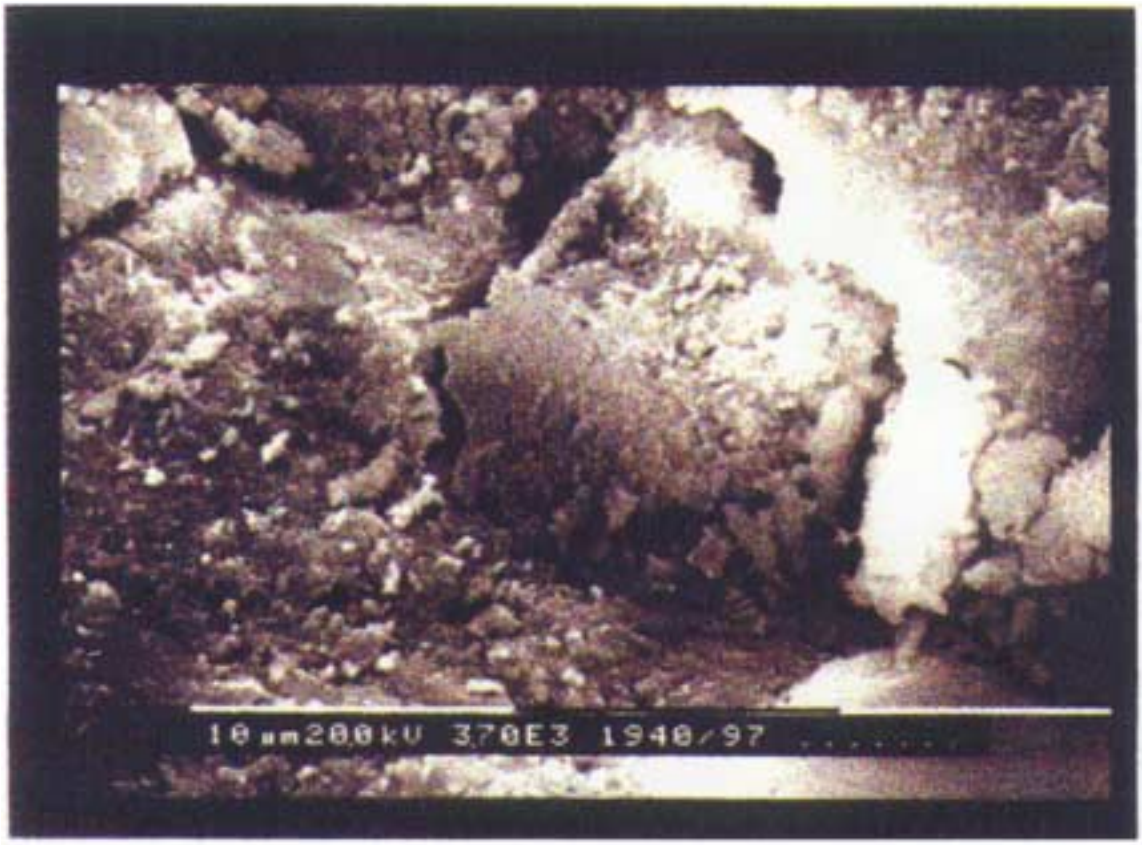
Photograph 1: Shows Setsco staff coring at Marina Square.

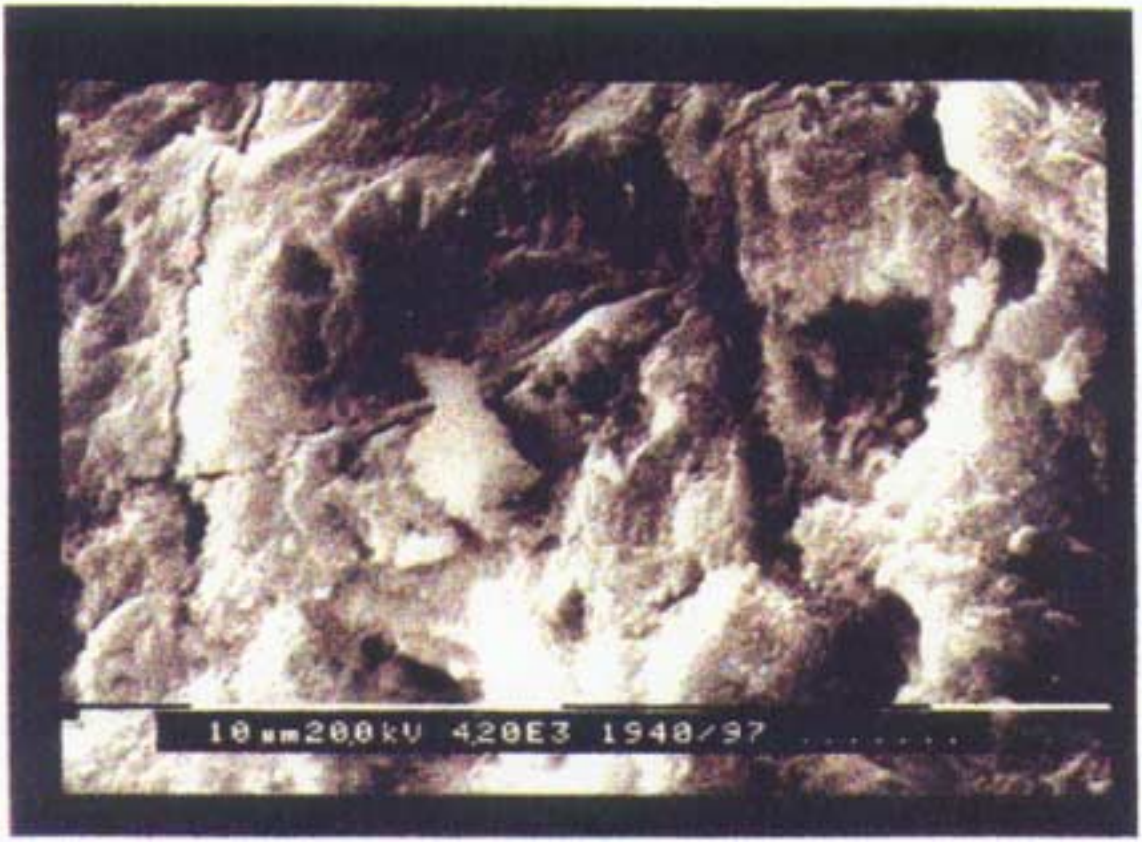
Photograph 2: Shows one set of Ø 100 x 900mm core after coring.

Photograph 3: Shows one set of Ø 150 x 900mm core after coring.



Photograph 4: Shows one set of 3 nos. of Ø 150 x 50mm cores for water permeability test.





Photographs 5 & 6: SEM on control concrete at 28 days.

Photograph 7 & 8: SEM on treated concrete with XYPEX Admix C-2000 Waterproofing at 28 days.

2. CONCLUSIONS

2.1 Setsco Services Pte Ltd (SETSCO) is a SINGLAS (Singapore Laboratory Accreditation Scheme) accredited laboratory whose quality system is based on ISO/IEC Guide 25 and the test results are officially recognised in Singapore.

2.2 The following tests which were proposed by Xypex in their methodology were used to gauge the performance of Xypex

a. Reduction of temperature during the heat of hydration
b. Increase of concrete compressive strength
c. Improvement in the water permeability of concrete (i.e. less voidage in the concrete)

2.3 The concrete mix details proposed by Xypex are given in Table 5a whereas those of the control concrete mix are shown in Table 5b. Both mixes are Grade 40MPa concrete. The cement contents of the Xypex and control mixes are 355kg/m^2 and 410kg/m^2 respectively while the corresponding water / cement ratios are 0.45 and 0.41. The same source of cement was used in both pours.

2.4 The temperature monitoring results indicate that the measured peak and differential temperatures for the Xypex Mix are lower than the control mix. This is likely to be due to the lower cement content of the Xypex mix as compared to the control mix.

2.5 It is evident from the cube compressive strength results that the strength of the control mix is higher than the Xypex mix with the exception of the 1 day results. The strength gain with time was greater in the case of the control mix as compared with the Xypex mix. This is likely to be due to the higher cement content of the control mix.

2.6 Based on the results of the core compressive strength, it is apparent that the strength of the control mix was slightly lower than the Xypex mix. This trend is not consistent with the cube compressive strength results. The cube and core compressive strength of the Xypex mix appears to be consistent at 7 and 28 days. However, for the control mix, the core compressive strengths were lower than cube compressive strengths.

2.7 The magnification at which Scanning Electron Microscopy (SEM) was carried out showed a normal concrete matrix in the case of the control mix and evidence of Xypex crystals on the Xypex treated mix at 28 days. This would concur with Xypex's claim of the formation of crystalline structure in treated concrete. Information regarding the pore (void) and crystal size was not given in the SEM test results.

2.8 Based on the water permeability test results, the control mix showed no leakage from 1.4 to 4.2 bars, however, water leakage occurred at 7 bars. For the Xypex concrete mix, no leakage was observed from 1.4 to 7 bars. Water penetration was not recorded as was required in SETSCO's proposal. In this test, the permeability coefficient is not derived, however, the test does show an improvement in the water prermeability when comparing the Xypex concrete mix to the control concrete mix. However, no acceptability criteria has been defined.

2.9 The assessment of the results are summarized as follows:

a) The Xypex mix appears to successfully restrict the water ingress under head pressures.

b) The Xypex mix shows comparable compressive strengths to the control mix, but with lower cement content.

c) Lower cement content has a beneficial effect on the thermal gradients in large pours.

d) Inclusion of Xypex in concrete does not appear to adversely affect the early age strength gain, stripping times etc. to any significant extent, based on the data presented herein.

3. REVIEW OF AVAILABLE TECHNICAL DATA SHEETS AND METHODOLOGY

3.1 No temperature monitoring data and core compressive strength results were available for TEL to review.

3.2 Permeability test reports from Pacific Testing Laboratory and Industrial Museum of Technology in Vienna are given in Appendix A and the review of which is as follow.

Pacific Testing Laboratory reported “The Xypex treated samples also exhibited leakage at each state of increased pressure, but consistently followed decreasing leakage patterns approaching zero. It can therefore be stated that the Xypex chemical treatment sealing effect eliminates all measurable leakage (refer to Appendix A, Permeability test of Xypex treated and untreated concrete samples, 1982, p.4)”.

Industrial Museum of Technology in Vienna reported “The so far executed tests demonstrate that the concrete test specimens coated with Xypex have an impermeability to water quite superior to the uncoated ones (refer to Appendix A, Expert Opinion -re Concrete Sealing Material / 1st Part, 1983, p.7)”.

3.3 Australian Manufacturers of Xypex claims “The chemicals in Xypex are in the concrete, they are available to the by-products of cement hydration and water present. The chemical reaction takes place, a crystalline structure is formed and as the chemicals in Xypex continue to migrate through the water this crystalline growth will form behind this advancing front of chemicals. This reaction will continue until the chemicals in Xypex are either depleted or run out of water (refer to Appendix A., How does Xypex work? p.2)”. Scanning electronic microscopic examination was conducted as part of this evaluation to conclusively assess the existence of crystalline growth.

4. RESULTS AND DISCUSSION

4.1 Survey Techniques / Laboratory Testing

4.1.1 Temperature Monitoring

Thermo-couples were placed in the positions assigned in the concrete blocks and connected to a data Logger before casting the concrete blocks. The temperature was recorded by the Data Logger. The test duration was 7 days. The temperature was taken every 30 minutes. Ambient temperature was recorded at half an hour intervals. Further details are given in SETSCO's test report in Appendix C.

4.1.2 Cube Compressive Strength

Fifteen 150 x 150 x 150mm concrete cubes were cast at the same time during the placement for each of the two test blocks. The compressive strength test was carried on the cubes at 1, 3, 7, 28 and 56 days in accordance to SS 78.

4.1.3 Core Sampling & Compressive Strength

Core samples of 100mm in diameter were taken to a depth of 900mm. The core sample locations and description were noted and tabulated in SETSCO's report given in Appendix C. The test specimens for compressive strength were cut from the top, middle and bottom of the core sample. Core samples were tested to BS 1881:Part 120:1983 to determine the compressive strength of the samples. The compressive strength test was carried out on the cores at 7 and 28 days.

4.1.4 Scanning Electron Microscopy

SETSCO had obtained 1 random core sample for scanning electron microscopy from the top of each of the Xypex treated and control concrete blocks. Scanning electronic microscopic examination was conducted to conclusively assess the existence of crystalline growth. Samples were taken after 28 days of curing. The magnification required was to be sufficient to permit the examination of the microscopic pores and capillaries in the matrix of the concrete sample for evidence of Xypex crystal.

4.1.5 Water Permeability

150mm diameter core samples were taken from each of the Xypex treated and control concrete blocks at 7 and 28 days and subjected to a water permeability test specified by the Client. According to the information provided, the test apparatus for the water permeability test is modeled after the test apparatus described in the Corps of Engineer's Test No CRD-C48-73 with several variations. The test specimens were cut from the top, middle and bottom of the core samples. The test details are as follow.

- 1.4 bars on the 1st and 2nd day
- 2.8 bars on the 3rd day
- 4.2 bars on the 4th day
- 7 bars on the 5th to 15th day

SETSCO's test report is given in Appendix C together with the details of the test procedure.

4.2 Results and Discussion

4.2.1 Temperature Monitoring

The temperature results obtained by SETSCO are given in Appendix C and summarised in Table 4.2. It is evident from these results that the peak and maximum differential temperatures for the control mix are 77^{o}C and 23^{o}C respectively whereas the corresponding values for the Xypex mix are 69^{o}C and 18^{o}C.
The temperature measured from the trial block with Xypex was lower compared to the control block. This is due to the lower cement content for the Xypex mix as compared to the control mix (see Tables 5a & 5b for the mix designs). Placement temperature as given by CWMPL for the Xypex treated concrete and control mix concrete was 26.2^{o}C and 27.2^{o}C respectively (see Appendix B). The cement content for the Xypex treated concrete and control concrete are 355 kg/m^2 and 410 kg/m^2 respectively. The same source of cement was used in both pours.

The Xypex mix reached its peak temperature slightly earlier than the control mix. This could be due to a slightly accelerating effect by Xypex or a slight retarding effect by the admixtures in the control mix. However, this is not particularly significant.

4.2.2

The Cube compressive strength results are summarised in Table 4.2. It can be seen from these results that the average cube compressive strength results for the control mix at 1, 3, 7, 28 and 56 days are 18.5, 31.5, 41.5, 54.0 and 58.0 N/mm^2 respectively whereas the corresponding values for the Xypex mix are 20.5, 30.0, 37.0, 46.5 and 49.0 N/mm^2. The results show that the compressive strength of the control mix is higher than the Xypex mix.

4.2.3 Core Sampling & Compressive Strength

SETSCO's core compressive strength results are given in Appendix C and summarised in Table 4.2. The results indicate that the average core compressive strength results for the control mix at 7 and 28 days are 39.5 and 42. 0 N/mm^2 respectively while the corresponding results for the Xypex mix are 38.5 and 45.0 N/mm^2. It can be seen from these results that the core compressive strength of the control mix is slightly lower than that of the Xypex mix.

4.2.4 Scanning Electron Microscopy (SEM)

The magnification at which Scanning Electron Microscopy was carried out showed a normal concrete matrix on the control mix and evidence of Xypex crystals on the Xypex treated mix at 28 days. This would concur with Xypex's claim of the crystallization of crystals in treated concrete. Information regarding the pore (void) size and crystal size was not given with the SEM test results.

4.2.5 Water Permeability

The results are summarised in Table 4.2. They indicate that the Control mix showed no leakage from 1.4 to 4.2 bars. However water leakage occurred at 7 bars. No leakage was observed from 1.4 to 7 bars for the Xypex concrete mix. The permeability coefficient of the concrete was not measured neither was the water penetration and therefore no acceptable criteria can be defined. These results do however indicate a qualitative improvement in the permeability of the Xypex mix over the control concrete mix.

5. ASSESSMENT OF RESULTS

The assessment of results are summarized as follows:

a) The Xypex mix appears to successfully restrict the water ingress under head pressures.

b) The Xypex mix shows comparable compressive strengths to the control mix, but with lower cement content.

c) Lower cement content has a beneficial effect on the thermal gradients in large pours.

d) The inclusion of Xypex in concrete does not appear to adversely affect the early age strength gain, stripping times etc. to any significant extent based on the data presented.

Table 4.2 :

Xypex Performance Test on G40 Concrete

Type of Test	Control Mix Results	Xypex Mix Results
Water permeability at 7 days	No leakage occurred from 1.4 bar to 4.2 bar Water leakage occurred at 7 bar	No leakage occurred from 1.4 bar to 7 bar
Average CUBE Compressive Strength at 1 day at 3 days at 7 days at 28 days at 56 days	 18.5 N/mm^2 31.5 N/mm^2 41.5 N/mm^2 54.0 N/mm^2 58.0 N/mm^2	 20.5 N/mm^2 30.0 N/mm^2 37.0 N/mm^2 46.5 N/mm^2 49.0 N/mm^2
Average CORE Compressive Strength at 7 days at 28 days	 39.5 N/mm^2 42.0 N/mm^2	 38.5 N/mm^2 45.0 N/mm^2
Scanning Electron Microscopy (SEM) Test	Normal Concrete Matrix noted	Xypex crystals noted
Maximum Temperature Temperature difference	77^{o}C 23^{o}C	69^{o}C 18^{o}C

XYPEX
AUSTRALIA

Table 5A

Project: SINGAPORE ARTS CENTRE - PUMP MIX

Work: Construction of Main Basement Works
Contractor: Penta Ocean Construction Co Ltd

1.	1.1	Characteristic Strength		Specific 40N/mm^2 at 28 days below which 5% of test results may be expected to fall
	1.2	Cement Type		Ordinary Portland Cement
	1.3	Aggregate Type	: Coarse : Fine	Crushed Granite Natural/Manufactured Sand
	1.4	Free Water/Cement Ratio Specified		
2	2.1	Slump for Concrete		95 + \ - 25 mm
	2.2	Maximum Aggregate Size		20mm
	2.3	Free Water Content		Nominal Maximum Water 160kg/m^3
3	3.1	Cement Content		355 kg/m^3
	3.2	Total Aggregate Content		1775 kg/m^3
	3.3	Proportion of Fine Aggregate		39.5%
	3.4	Fine Aggregate Content Grading to SS31, S.G. 2.61 (surface dry)		700 kg/m^3
	3.5	Coarse Aggregate Content S.G. 2.62 (surface dry)		1075 kg/m^3
4	4.1	XYPEX Admix C-2000		Dose Rate = 0.9% by weight of O.P.C. 3.2 kg/m^3
5	5.1	Concrete Density		2293 kg/m^3
6		MIX SUMMARY		

Mix Mpa	Slump (mm)	Cement (Kg/m^3)	20mm Graded (Kg/m^3)	Sand (Kg/m^3)	Nominal Max/Water (Kg/m^3)	Max A/C Ratio	W/C Ratio	XYPEX Admix C-2000 (Kg/m^3)
40	95 +/-25	355	1075	700	160	3.00	0.45	3.2

SUPERMIX CONCRETE PTE LTD
CONCRETE MIX DESIGN

Table: 5B

Project: Construction of Pile Foundation and Main Basement Works
Location: Singapore Arts Centre
Contractor: Penta Ocean Construction Co Ltd

1	1.1 Concrete Grade 1.2 Concrete Type 1.3 Slump for Concrete		40 N/mm^2 Pump Mix 125mm	
2	2.1 Characteristic Strength 2.2 Design Standard Deviation 2.3 Designed Margin 2.4 Target Mean Strength 2.5 Specified Water/Cement Ratio		40 N/mm^2 at 28 days below which 5% of test results may be expected to fall. 4.57 N/mm^2 1.64 x 4.57 N/mm^2 = 7.50 N/mm^2 40 + 7.50 N/mm^2 = 47.50 N/mm^2 0.41	
3	3.1 Cement	OPC	Brand: PMCW (S)	S.G.: 3.15
	3.2 Fine Aggregate	Natural	Size: Grading to SS31	S.G.: 2.61 (Surface Dry)
	3.3 Coarse Aggregate	Crushed	Size: 20mm	S.G.: 2.61 (Surface Dry)
	3.4 Water	PUB	650 ml/100 kg of cement (Plasticizer & Retarder) 400 ml/100kg of cement (Superplasticizer)	
	3.5 Admixture 3.6 Reagent	Cormix P4 Cormix SP1		
4	4.1 Cement Content 4.2 Water Content 4.3 Concrete 4.4 Proportion of Fine Aggregate 4.5 Air Content		410 kg/m3 170 kg/m3 2353 kg/m3 42.90% 2%	

5	5.1 Summary (kg/m^3)			Coarse Aggregate	Admixture	Reagent
	Cement	Water	Fine Aggregate	1010	3.17	1.97
	410	170	758	Percentage of Fine Aggregate		42.90%
	Water/Cement Ratio		41%			
6	Remarks: The Characteristic strength shall conform to BS 5328 & SS289 This design mix is done under surface dry and saturated conditions					

AUSTRALIA

PROPOSED METHODOLOGY FOR CONDUCT OF FIELD TEST
XYPEX ADMIX C-2000

TEST SITE

- To consist of formwork to dimensions of: 2.0 m x 2.0 m x 0.9 m (deep)
- Formwork material to be 12 mm water resistant plywood
- Reinforcement steel to comply with ART CENTRE design requirements in all regards
- Site to be moistened prior to concrete placement

CONCRETE

- As per mix design - ART CENTRE Design 1 Mark IV (attachment 1)
- XYPEX Admix C-2000 to be dosed with regard to protocol (attachment 2) at the rate of 0.9% cementitious content
- “Slump” to conform to specified range per mix design (attachment 1)
- Concrete is to be placed by direct placement
- Normal minimum standard for compaction and finishing apply (Refer to attachment 3)
- Elapsed time from batching to commencement of placement not to exceed ninety (90) minutes. As per attachment 2 minimum elapsed interval between batching and placement is to be ten (10) minutes.

CURING

- Water - Wet covering (permanently wet - material impregnation) for minimum three (3) days

TESTING / OBSERVATIONS

Temperature

- Temperature of hydration to be monitored for minimum period of seven (7) days. Temperature to be recorded at 30 minute intervals for three days after placement and hourly for duration of week.

- “K” type Thermo Couplers are to be placed prior to concrete placement in configuration as detailed by SETCO Services Pte Ltd (Ref: BTD/96/1009/XLP/gst) [Attachment 5]

- Thermo couplers to be connected to Data Logger/s.

- Ambient temperature to be recorded on a frequent and regular basis at maximum elapsed intervals of six (6) hours.

Compressive Strength (Cubes)

- Fifteen (15) test cubes (attained to applicable standards) to be gathered at time of placement of test block to enable the following:

- Minimum three (3) observations at each of the following intervals, for the test only. Thereafter testing of cubes to be to industry standard.

    - 24 hours
    - 3 days
    - 7 days
    - 28 days
    - 56 days

Compressive Strength (Cores)

- Core samples are to be collected and tested in accordance with all applicable standards and as detailed by SETSCO (Attachment 5)

Physical Examination

- Scanning electronic microscopic examination to be conducted to conclusively assess the existence of crystalline growth, in a minimum of two (2) random samples taken at a minimum of seven (7) days from a cured sample. The magnification required is to be sufficient to permit the examination of the microscopic pores and capillaries in the matrix of the concrete sample for evidence of XYPEX crystal.

Control Sample - Comparative Testing

- Testing regime as above with the exception of Physical examination (Scanning electronic) to be undertaken as a control for comparative testing.

SETSCO SERVICES PTE LTD

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Your Ref: **JM/SC/SAC/214/976** Our Ref: **B 20179/XLP** Date: **24/03/97**

TEST REPORT

(This Report is issued subject to the conditions set out overleaf)

Subject : Temperature Monitoring, Compressive Strength Test, Water Permeability Test and Scanning Electronic Microscopic (SEM) Examination on the control and treated concrete with XYPEX Admix C-2000 Waterproofing were requested by Jingslink Marketing Pte Ltd on 10/01/97.

Tested for :

1. **Jingslink Marketing Pte Ltd**
   50 Jalan Sultan Road
   Jalan Sultan Centre
   Singapore 198974
   Attn.: Mr. Chan A-Lam

2. **XYPEX Australia**
   Concrete Waterproofing Manufacturing Pte Ltd
   45 Union Road
   Lavington NSW 2641
   Australia
   Attn.: Mr. Loch W. Jackson

Method of Test : Proposed methodology for conduct of field test of XYPEX Admix C-2000 by Australian Manufacturers of XYPEX.

Project References : Art Centre Project
The Esplanade - Theatres on the Bay

Description of Sample : One no. of 2.0 x 2.0 x 0.9 m concrete block treated with XYPEX Admix C-2000 was cast on 14/01/97.

One no. of 2.0 x 2.0 x 0.9 m control concrete block was cast on 22/01/97.

The above castings was done at Marina Square for Art Centre project and witnessed by Setsco & PWD officials.

B 20179/50/gsr

1. Temperature monitoring on Control and Treated Concrete with Xypex Admixture C-2000 Waterproofing

The "K" type Thermo Couples were put into the position of the block prior to the concrete placement. The distribution of the thermo couples and marking numbers are given as follows:

Treated Concrete:		Marking No.:
Position of the thermo couples:		
One point in the centre of the block	-	1
Four points in the corner of the top surface of the block	-	2, 5, 6, 8
Four points in the corner of the bottom surface of the block	-	3, 4, 7, 9
One point in the centre of the top surface of the block	-	15
Two points in the centre of the bottom surface of the block	-	14, 16
Four points in the centre of the four sides surface of the block	-	10, 11, 12, 13
Two points for shaded ambient temperature	-	17, 18

Control Concrete:		
Position of the thermo couples:		
One point in the centre of the block	-	1
Four points in the corner of the top surface of the block	-	4, 7, 10, 13
Four points in the corner of the bottom surface of the block	-	5, 8, 11, 14
One point in the centre of the top surface of the block	-	3
Two points in the centre of the bottom surface of the block	-	2
Four points in the centre of the four sides surface of the block	-	6, 9, 12, 15
Two points for shaded ambient temperature	-	16, 17

The thermo couples were connected to a Data Logger and the temperature in the concrete blocks were recorded every 30 minutes during the first 7 days after concreting.

All the temperature readings against the time are shown in Appendix 1.

Figures 1 and 2 show the change in temperature readings at different times for three measuring points including ambient temperature. The three measuring points presented in Figures 1 and 2 were selected from the points with the highest temperature (centre of block) and 2 points with the lowest temperature (corner of blocks). The temperature readings on the other points fall within the above limited points in Figures 1 and 2.

2. Compressive Strength Test

Cubes : 15 nos 150 x 150 x 150mm cubes of control and treated concrete each were received from Penta-Ocean Construction Co. Ltd. All the cubes were cured in water until the age of test. Compressive strength test on the cubes were determined in accordance with BS 1881 Pt : 116 : 1983. The compressive strength test results are shown in Tables 1 and 2.

Cores : 2 nos of ϕ 100 x 900mm cylinders of control and treated concrete each were cored near the centre of the block at 7 and 28 days at Marina Square by Setsco (see photographs 1 and 2 attached). The compressive strength on the concrete cores were determined in accordance with BS 1881 : Pt 120 : 1983. The results of the compressive strength test are given in Table 3.

3. Water Permeability Test

According to the test method, the objective of this test was to measure the rate of outflow of water from the concrete test specimen.

2 nos of ϕ 150 x 900 mm cylinders of control and treated concrete each were cored near the centre of the block at 7 and 28 days at Marina Square by Setsco, (see photographs 3 and 4 attached).

1 no of ϕ 150 x 50mm test specimen each was cut from the top, middle and bottom of the control and treated core sample. The water pressure on the test specimen was applied by incremental increase as follows:

1.4 bar on the 1st day
2.8 bar on the 4th day
4.2 bar on the 7th day
7.0 bar on the 10th day and maintained for 7 days

The volume of water percolating through the samples was collected from the bottom of the test specimens daily. The results are shown in Table 4.

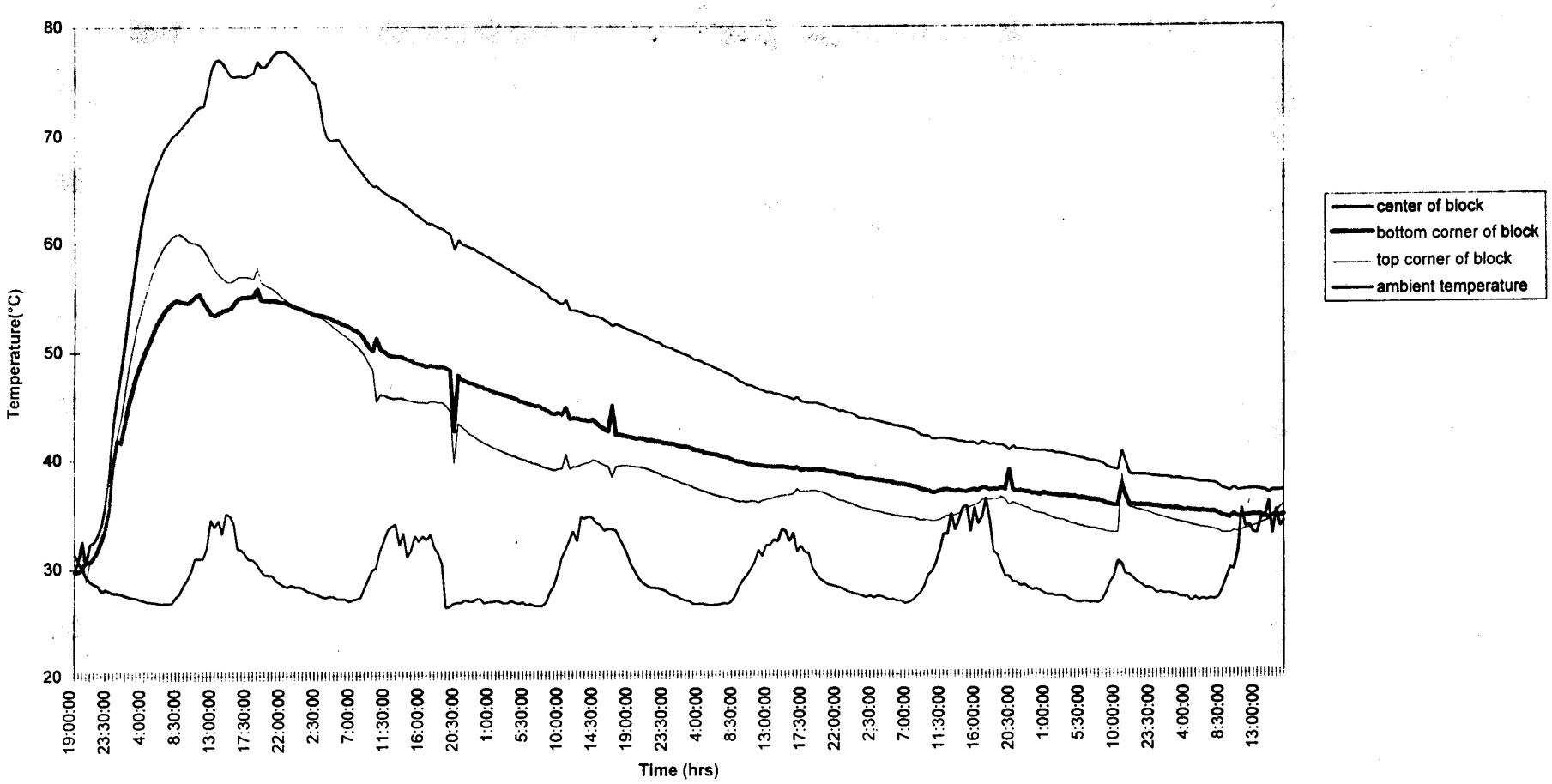
4. Scanning electronic microscopic examination

Scanning electronic microscopic examination was conducted on the cores taken from the upper portion of the control concrete and concrete treated with XYPEX Waterproofing at 28 days. See photographs 5 and 6 attached for microscopic view of control concrete and photographs 7 and 8 attached for microscopic view of treated concrete).

JASBEER SINGH
TESTING OFFICER

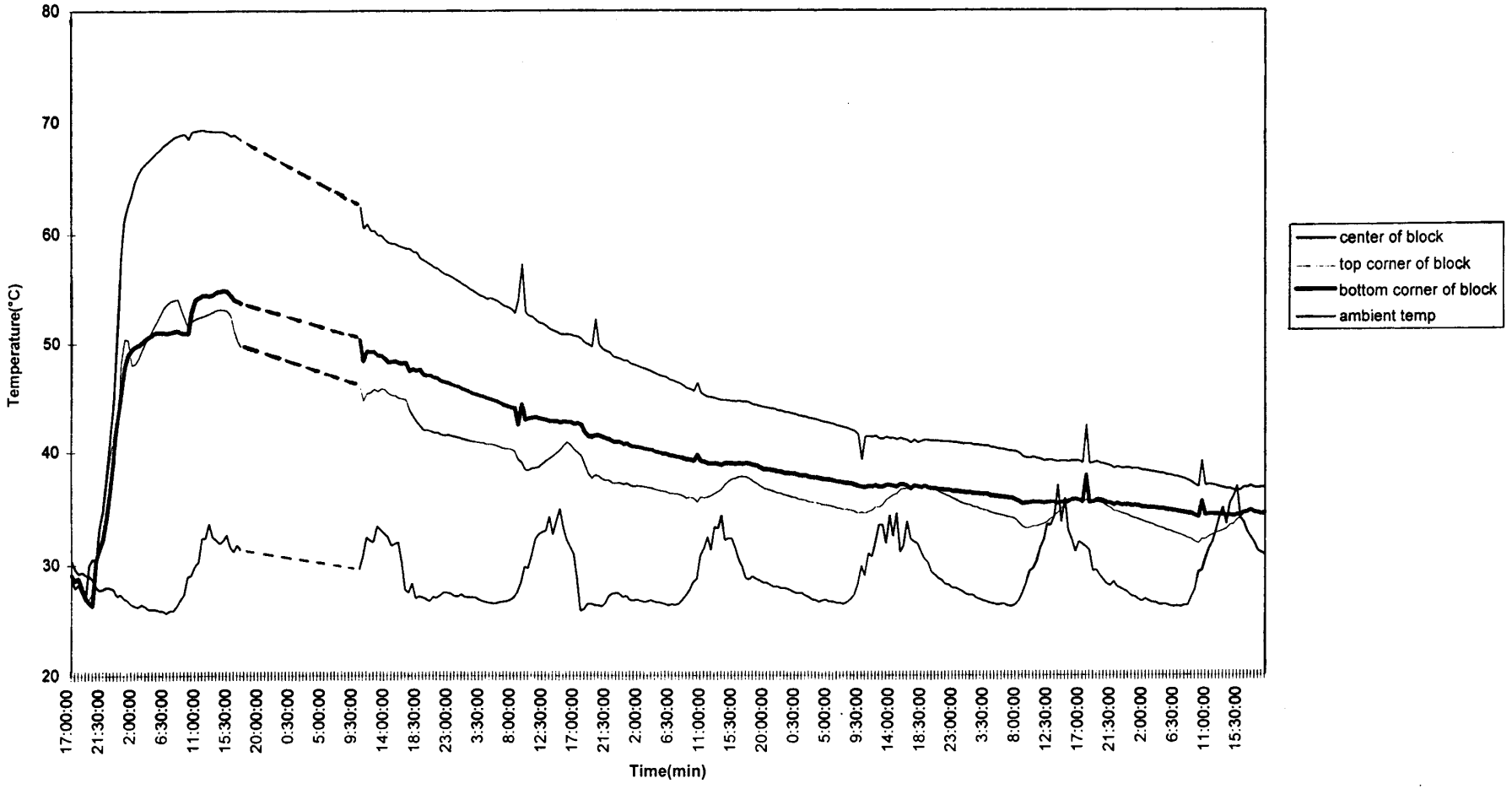
XU LIPING
MATERIAL ENGINEER
BUILDING TECHNOLOGY DEPARTMENT

Figure 1 : Monitoring of Temperature on G40 Concrete at First 7 Days



SETSCO

Figure 2 : Monitoring of Temperature at First 7 Days on G40 Concrete with Xypex Waterproofing



"----" denotes the interrupt by power failure

SETSCO

Table 1 : Compressive Strength Test on Control Concrete Cubes

Sample Reference		Control Concrete														
Specimen Reference		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Size of Cube	(mm)	150														
Date of Cast		22/01/97														
Date of Test		23/01/97			25/01/97			29/01/97			19/02/97			19/03/97		
Age at Test	(days)	1			3			7			28			56		
Area	(mm^2)	22,500														
Weight of Specimen	(g)	8034.9	8010.9	8027.3	7955.9	8058.6	8014.9	8056.1	8042.0	8149.0	8068.2	8086.9	8091.3	7974.1	8102.4	8063.6
Compressive Strength	(N/mm^2)	18.5	18.5	18.0	32.0	29.5	32.5	43.0	40.0	42.0	52.0	56.0	53.5	60.5	56.5	57.0
Average Compressive Strength	(N/mm^2)	18.5			31.5			41.5			54.0			58.0		

SETSCO

Table 2 : Compressive Strength Test on Concrete Cubes Treated with Xypex Waterproofing

Sample Reference		Treated Concrete with XYPEX Waterproofing														
Specimen Reference		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Size of Cube	(mm)	150														
Date of Cast		14/01/97														
Date of Test		15/01/97			17/01/97			21/01/97			2/11/97			3/11/97		
Age at Test	(days)	1			3			7			28			56		
Area	(mm^2)	22,500														
Weight of Specimen	(g)	7952.4	7963.4	7914.7	7951.4	8006.4	7785.1	7963.7	8033.7	8055.6	7878.5	7875.7	7956.8	7848.3	7925.4	7955.7
Compressive Strength	(N/mm^2)	21.0	20.5	20.0	29.5	31.0	31.5	38.5	34.5	38.0	46.5	46.5	46.0	48.5	50.0	48.5
Average Compressive Strength	(N/mm^2)	20.5			30.0			37.0			46.5			49.0		

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Table 3 : Visual Examination and Compressive Strength Test on Concrete Core

Sample Reference		Control Concrete						Treated Concrete with XYPEX Waterproofing					
Specimen Reference		1	2	3	4	5	6	1	2	3	4	5	6
Date of Cast		1/22/97						14/02/97					
Date of Coring		30/01/97			21/02/97			22/01/97			13/01/97		
Age at Test	(days)	7			28			7			28		
Length of Core (mm)	Maximum	105.9	98.9	102.3	108.2	107.7	105.9	106.9	105.5	107.1	103.2	103.9	104.3
	Minimum	105.3	98.4	101.9	107.5	107.2	105.3	106.6	104.2	106.0	102.0	103.1	103.9
Excess Voidage(in accordance with BS 1881 : Part 120 : 1983 : Fig.1)		0	0.5	0	1.5	0.5	0.5	0	0.5	1.5	0.5	0.5	0
Void Classification		Small	Large	Small	Large	Medium	Medium	Large	Large	Large	Large	Large	Large
Average Diameter	(mm)	100.1	100.2	100.3	100.4	100.4	100.4	99.9	99.6	99.8	100.3	100.3	100.4
Average Length of Capped Specimen	(mm)	108.8	102.5	105.3	110.9	110.4	109.5	109.9	107.7	110.0	107.2	106.6	107.1
Compressive Strength	(N/mm^2)	38.5	42.0	37.5	42.5	40.5	42.5	41.5	35.0	38.5	44.0	44.0	47.0
Density	(kg/m^3)	2300	2295	2300	2290	2300	2300	2325	2315	2300	2315	2305	2325

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Table 4 : Water Permeability Test

Sample Reference		Control Concrete						Treated Concrete with XYPEX Waterproofing					
Specimen Reference		1	2	3	1	2	3	1	2	3	1	2	3
Date of Cast		22/01/97						14/01/97					
Date of Coring		30/01/97			20/02/97			22/01/97			2/12/97		
Age of Curing	(days)	8			29			8			29		
Specimen Size	(mm)	ϕ150 x 50											
Volume of water moving through the sample(mL) :													
At 1 bar on	1st day	0	0	0	0	0	0	0	0	0	0	0	0
At 2.4 bar on	2nd day	0	0	0	0	0	0	0	0	0	0	0	0
At 4.2 bar on	3rd day	0	0	0	0	0	0	0	0	0	0	0	0
At 7.0 bar on	4th day	0	0	0	0	0	0	0	0	0	0	0	0
	5th day	10	0	4	10	0	0	0	0	0	0	0	0
	6th day	30	20	25	74	13	0	0	0	0	0	0	0
	7th day	65	20	60	78	20	0	0	0	0	0	0	0
	8th day	70	30	60	45	10	0	0	0	0	0	0	0
	9th day	70	30	60	35	10	0	0	0	0	0	0	0
	10th day	70	30	60	46	10	0	0	0	0	0	0	0

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