Table 2 Environmental Water Quality Standards

(1) Standards relating to Human Health

Item	Standard values
Cadmium	0.01 mg/l or less
Cyanide	Not detectable
Organic phosphorus	Not detectable
Lead	0.1 mg/l or less
Chromium(hexavalent)	0.05 mg/l or less
Arsenic	0.05 mg/l or less
Total mercury	0.0005 mg/l or less
Alkyl mercury	Not detectable
PCB	Not detectable

Table 3 Environmental Water Quality Standards

(2) Standards relating to Living Environment
a. Rivers

Category	Item / Purpose of water use	Standard values'				
		pH	Biochemical oxygen demand (BOD)	Suspended solids (SS)	Dissolved oxygen (DO)	Number of coliform groups
AA	Water supply, class 1 : conservation of natural environment, and uses listed in A—E	6.5—8.5	1 mg/ℓ or less	25 mg/ℓ or less	7.5 mg/ℓ or more	50 MPN/100mℓ or less
A	Water supply, class 2 : fishery, class 1 : bathing and uses listed in B—E	6.5—8.5	2 mg/ℓ or less	25 mg/ℓ or less	7.5 mg/ℓ or more	1,000 MPN/100mℓ or less
B	Water supply, class 3 : fishery, class 2, and uses listed in C—E	6.5—8.5	3 mg/ℓ or less	25 mg/ℓ or less	5 mg/ℓ or more	5,000 MPN/100mℓ or less
C	Fishery, class 3 : industrial water, class 1, and uses listed in D—E	6.5—8.5	5 mg/ℓ or less	50 mg/ℓ or less	5 mg/ℓ or more	—
D	Industrial water, class 2 : agricultural water[2], and uses listed in E	6.0—8.5	8 mg/ℓ or less	100 mg/ℓ or less	2 mg/ℓ or more	—
E	Industrial water, class 3 : conservation of environment	6.0—8.5	10 mg/ℓ or less	Floating matter such as garbage scould not be observed	2 mg/ℓ or more	—

Table 4 b. Lakes

Category	Purpose of water use / Item	Standard values				
		pH	Chemical oxygen demand (COD)	Suspended[1] solids (SS)	Dissolved oxygen (DO)	Number of coliform groups
AA	water supply, class 1 ; fishery, class 1 ; conservation of natural environment, and uses listed in A—C	6.5—8.5	1 mg/ℓ or less	1 mg/ℓ or less	7.5 mg/ℓ or more	50 MPN/100 mℓ or less
A	Water supply, classes 2 and 3 ; fishery, class 2 ; bathing and uses listed in B—C	6.5—8.5	3 mg/ℓ or less	5 mg/ℓ or less	7.5 mg/ℓ or more	1,000 MPN/100 mℓ or less
B	Fishery, class 3 ; industrial water, class 1 ; agricultural water, and uses listed in C	6.5—8.5	5 mg/ℓ or less	15 mg/ℓ or less	5 mg/ℓ or more	—
C	Industrial water, class 2 ; conservation of environment	6.0—8.5	8 mg/ℓ or less	Floating matter such as garbage shall not be observed	2 mg/ℓ or more	—

Table 5 c. Nitrogen and phosphorus in lakes and reservoirs

Category	Purpose of water use / Item	Standard velues	
		Total nitrogen[2]	Total phosphorus[2]
I	Conservation of natural environment, and uses listed in II—V	0.1 mg/ℓ or less	0.005 mg/ℓ or less
II	Water supply classes-1, 2 and 3 (excluding special types)? fishery class 1, bathing ; and uses listed inIII—V	0.2 mg/ℓ or less	0.01 mg/ℓ or less
III	Water supply class 3 (special types), and uses listed in IV—V	0.4 mg/ℓ or less	0.03 mg/ℓ or less
IV	Fishery class 2, and uses listed in V	0.6 mg/ℓ or less	0.05 mg/ℓ or less
V	Fishery class 3? industrial water ; agricultula water ; conservation of the living environment	1 mg/ℓ or less	0.1 mg/ℓ or less

Table 6 d. Coastal waters

Category	Purpose of water use / Item	Standard values				
		pH	Chemical oxygen demand (COD)	Dissolved oxygen (DO)	Number of coliform groups[1]	N-hexane extracts
A	Fishery, class 1 ; bathing ; conservation of natural environment, and uses listed in B—C	7.8—8.3	2 mg/ℓ or less	7.5 mg/ℓ or more	1,000 MPN/100 mℓ or less	Not detectable
B	Fishery, class 2 ; industrial water and uses listed in C	7.8—8.3	3 mg/ℓ or less	5 mg/ℓ or more	—	Not detectable
C	Conservation of environment	7.0—8.3	8 mg/ℓ or less	2 mg/ℓ or more	—	—

Table 7 Outline of the Ports and Marine Environment Implrovement Work

Classification	Item	Beginning	Outline of the work
1.Prevent pollution in the port	Port pollution prevention work	1972	Dredging work or water conveying work to be carried out vased on a pollution control program or by the order of the Home Affairs Minister and the sandcovering stipulated by other cabinet order Work to construct or improve the port pollution prevention facility
	Marine clean-up work	1974	Work to recover floating refuse and oil in the inner sea and inner bay (excluding ports and fishing ports areas, etc.).
	Construction of cleaning ships	1974	Work to construct cleaning ships needed to perform clean the water in the port
	Waste oil disposal work	1967	Work to construct or improve waste oil disposing facilities (by port authorities and private companies, etc.)
	Marine waste disposal facility construction work	1973	Work to construct or improve the acceptance facility, incineration and crushing facilities for waste which from ships and ocean facilities and waste produced during the work by the port authority
	Disposal of sunken ships	1974	Work to dispose of unidentified sunken ships in the port
	Stockpiling of materials to remove port contamination	1975	Work to stockpile the oil fences required to remove the oil contamination in the port
	Designing and research for sediment purification	1979	Designing and research necessary to implement sediment purification (by dredging to coverring) at in the area where sea bed contamination is pronouced
2. Maintenance of waste reclamation site	Waste reclamation revetment construction work	1973	Work to construct or improve the revetment for reclaiming the waste to be disposed of
	Wide area waste reclamation site construction work	1982	Work to construct or improve the waste reclamation site for wide area waste (generated in coastal areas and broader areas inland) disposal
3. Environmental improvement of the port	Green zone facilities construction work	1973	Work to construct or improve port environment improvement facilities such as the park or green zone
	Marine environment creating work	1988	Work such as the sand covering or improvement of the beach in order to create refreshing space for public access to the sea by improving the water bed quality

Table 8 Comparisons between techniques for assessment

	Hydraulic Experiment Labolatory Test	Numerical Simuration
Scale	model scale generally distorted	prototype scale no distortion
Dimension	three–dimension distorted effect	two–dimension multi–layer model full–3D model
Expression of geographical configuration	comparatively faithful	depend on grid number
Tide	difficult to generate arbitary–shaped tide	easy
Current	difficult	easy
Measurement	easily influenced by measuring apparatuses, technique, and envitonment	easy
Reproductibility	difficult	easy
Parameters	it obeys real physics	many parameters are need to be set

Table 9 Scale ratios of hydraulic model

item	Scale ratio
Horizontal length	L_r
Vertical length	H_r
Time (period)	$T_r = L_r H_r^{-1/2}$
Velocity	$V_r = H_r^{1/2}$
Discharge	$Q_r = L_r H_r^{3/2}$
Manning's Coef.	$n_r = H_r^{2/3} L_r^{-1/2}$
Diffusion Coef.	$K_r = L_r H_r^{1/2}$

Table 10 List of Discretization

Derivative	Finite-difference representation
$\frac{du}{dx} =$	$\frac{u_{i+1} - u_i}{\delta x} + O(\delta x)$
$\frac{du}{dx} =$	$\frac{u_i - u_{i-1}}{\delta x} + O(\delta x)$
$\frac{du}{dx} =$	$\frac{u_{i+1} - u_{i-1}}{2\delta x} + O(\delta x^2)$
$\frac{d^2u}{dx^2} =$	$\frac{u_{i+1} - 2u_i + u_{i-1}}{(\delta x)^2} + O(\delta x^2)$
$\frac{d^2u}{dx^2} =$	$\frac{-u_{i+2} + 16u_{i+1} - 30u_i + 16u_{i-1} - u_{i-2}}{12(\delta x)^2} + O(\delta x^4)$

CHAPTER 3 : DURABILITY AND REPAIR METHOD OF CONCRETE

A STUDY ON MORTARS TO ASSESS THE DURABILITY OF MASSIVE CONCRETE

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Abstract
This paper examined the influence of high temperature during the initial curing period on the durability of massive concrete. For this purpose, mortar specimens made with three types of cement and different mix proportions were cured in controlled temperature environments. The physical properties studied in this paper are compressive strength, diffusion coefficient of chloride ion, carbonation depth and microstructure of matrix.

It was recognized, from our experiments where specimens were cured at higher temperatures, that mortar qualities such as long-term strength, resistance to chloride ion penetration and resistance to carbonation, tended to deteriorate in comparison with standard curing at 20 °C. Accordingly, more attention should also be paid to the durability in massive concrete in addition to preventing thermal cracking.
Keywords:Durability, Massive Concrete, Compressive Strength, Diffusion Coefficient of Chloride Ion, Carbonation, Microstructure

1 Introduction

In massive concrete, the temperature frequently reaches and sometimes exceeds 70 °C and remains at that level for many hours. As a result, properties affecting durability may differ from those found in normal concrete structures. It is important to discover and understand material properties of massive concrete in order to construct reliable and durable concrete structures. The influence of high temperature on the durability of concrete was examined using mortar specimens cured under controlled temperature histories.

2 Preparation of specimens

2.1 Material

(a) Cement
In the experiments, ordinary portland cement (OPC) was employed primarily, and blast-furnace slag cement type B (BB) and low heat blast-furnace slag cement type B (LBB) were also used. The LBB is a blended cement in which low heat portland cement is replaced by

ground granulated blast-furnace slag, in the range of JIS blast-furnace slag cement type-B (over 30% up to 60 %). The chemical composition and physical properties of each type of cement are indicated in Table 1. and Table 2.

(b) Fine aggregate

The fine aggregate used was a river sand with maximum particle size of 2.5 mm and fineness modulus of 2.84.

2.2 Mix proportion of mortar

The mix proportions of mortar used in the experiments are indicated in Table 3.

Table 1. Chemical composition of cements

Type of cement	Chemical composition (%)								
	ig. loss	insol.	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	Total
OPC	1.0	0.4	21.8	5.8	2.6	63.4	1.5	2.2	98.7
BB	1.3	0.5	25.6	9.0	1.7	55.8	2.6	2.1	98.6
LBB	0.2	0.0	29.8	9.3	2.1	51.3	3.4	1.6	97.6

Table 2. Physical properties of cements

Type of cement	Specific gravity	Specific surface area (cm^2/g)	Compressive strength (MPa)				Hydration heat (J/g)		
			3day	7day	28day	91day	7day	28day	91day
OPC	3.15	3350	17.4	26.7	40.4	45.0	336	386	411
BB	3.02	4090	12.2	20.1	39.6	47.1	301	353	379
LBB	3.05	4580	5.6	10.7	30.1	46.1	159	193	237

Table 3. Mix proportion of mortar

Type of cement	Water cement ratio (%)	Weight per unit volume (kg/m^3)				
		Cement	Water	Sand	AE water reducing agent	AE agent
OPC	45	544	232	1345	8.07	5.44
	55	442	233	1452	6.56	4.42
	65	373	233	1516	5.51	3.73
BB	45	540	230	1334	8.01	5.40
	55	439	232	1453	6.52	4.39
	65	371	232	1508	5.48	3.71
LBB	45	541	231	1337	8.02	5.41
	55	440	232	1455	6.53	4.40
	65	370	232	1510	5.49	3.71

2.3 Manufacture of specimens and exposure to a temperature history
Mortars were mixed with a pan type mixer for 120 seconds and specimens were moulded in cylinders 5 cm in diameter and 10 cm in height. The specimens were kept in moulds with a relative humidity of 60 % for 1.5 to 3 hours after casting, and then they were subjected to a temperature history such as shown in Fig.1 in an environmental test chamber. When the temperature in the chamber fell to 20°C, specimen moulds were capped and sealed with sealing materials, and retained in a room with a constant temperature of 20°C and a relative humidity of 80 % for the specified terms(28 days and 91 days).

For reference, some of the specimens were removed from the moulds one day after casting and cured in water at 20°C as standard curing specimens until the tests.

3 Test methods

3.1 Compressive strength
The compressive strength of the specimens was measured at the age of 7, 28 and 91 days according to JIS A 1108.

3.2 Diffusion coefficient of chloride ion
At the age of 28 and 91 days, two or three test pieces of 10 mm thickness, were sliced off from some specimens. The test pieces were placed in the diffusion cell between distilled water and a 3 % saline solution. After the lapse of the specified testing term, chloride ions, which permeated the test pieces, were measured by the potentiometric titration method of silver nitrate solution. The diffusion coefficient was calculated according to Fick's 2nd law.

3.3 Carbonation
At the age of 28 and 91 days, each set of specimens was removed from the moulds or taken out of the water, then were kept in a room at a constant temperature of 20°C, and a relative humidity of 60 %. After

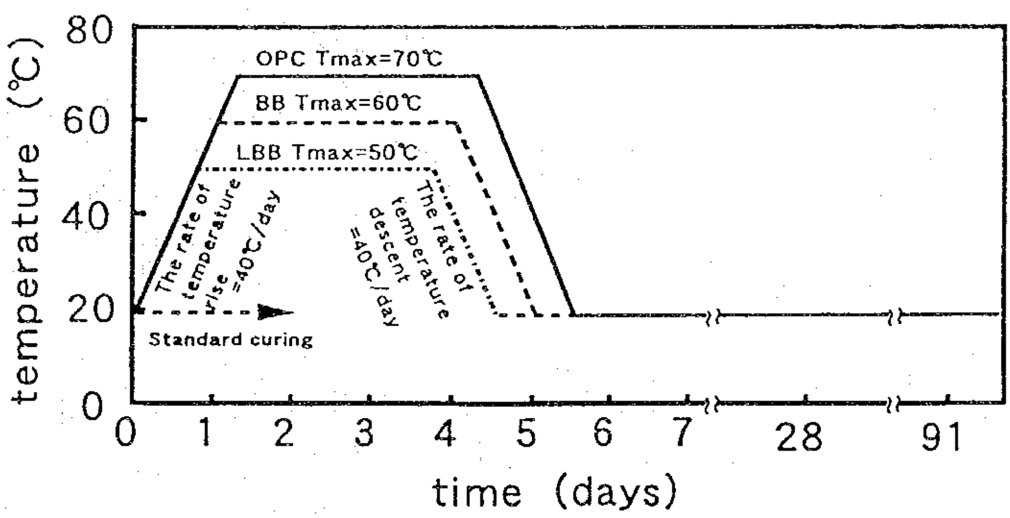


Fig.1 Temperature history patterns

a lapse of 2 and 4 months, carbonation depth of split specimens was measured by phenolphthalein method.

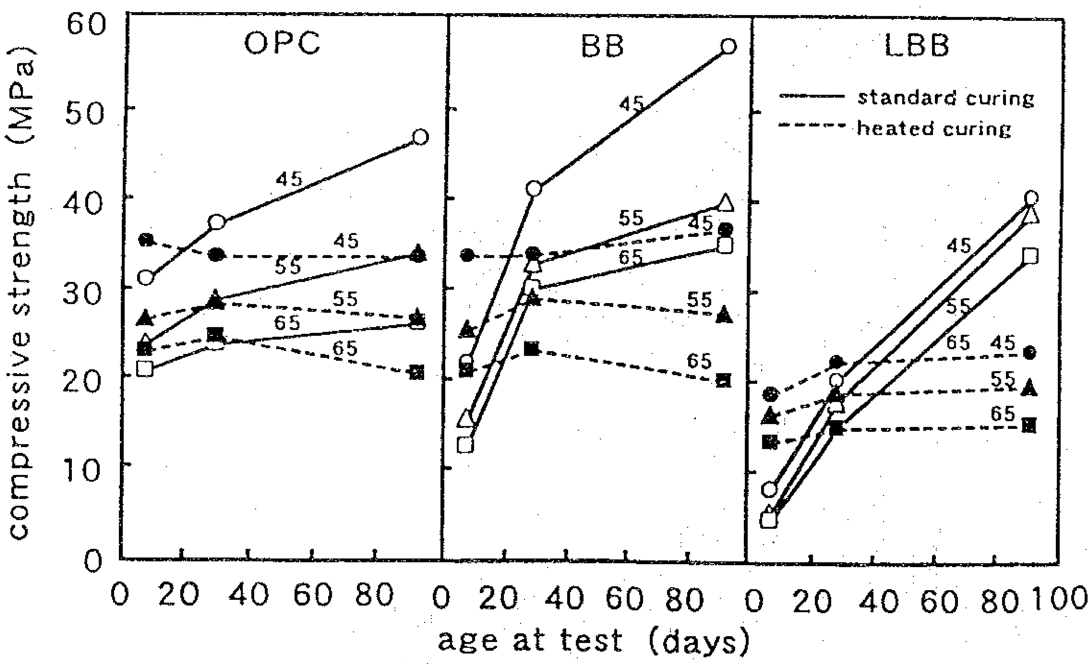
3.4 Microstructure of mortar

At a specified age, the mid section of some specimens was crushed into fragments 3 mm to 5 mm in size. The fragments were immersed in acetone for two hours, and hydration was terminated by D-dry to prepare test samples. Pore size distribution of the samples was measured with a mercury intrusion porosimeter. In addition, the microstructure of samples was observed with a scanning electron microscope.

4 Results and discussion

4.1 Compressive strength

The results of compressive strength tests are shown in Fig.2. It can be seen, from this figure, that for all cement types, the compressive strength of specimens subjected to heated curing was larger than standard curing at the age of 7 days. However, the compressive strength at the age of 28 and 91 days was less in comparison with the standard curing. This fact suggests that heated curing at an early ages accelerated hydration of cement, but inhibited the long-term process of hydration. This tendency was especially noticeable in BB and LBB which rely on the reaction of blast-furnace slag and have moderate strength development (Horiguchi et al., 1991).



Note:Numerical values represent W/C
Fig.2 Compressive strength test results

4.2 Diffusion coefficient of chloride ion

The diffusion coefficients of chloride ions are shown in Fig.3, which were obtained from the two month-long tests starting at either 28 days or 91 days.

The diffusion coefficients of OPC and BB mortar specimens increased when they were subjected to heated curing. On the contrary in LBB, the diffusion coefficients of specimens subjected to heated curing decreased. However, in terms of the duration of the curing periods, the diffusion coefficient of LBB of standard curing at the 91st day was noticeably less than the coefficient at the 28th day and became almost the same as those of specimens subjected to heated curing.

It may be recognized that the diffusion coefficients of BB and LBB were smaller than that of OPC regardless of the presence of a temperature history, and that BB and LBB had high resistance to chloride ion penetration (Gjørv et al., 1979; Otsuki et al., 1983; Shigeru et al., 1983; Fukute et al., 1992).

With respect to the W/C of mortar, when the W/C was small, the reduction of diffusion coefficients of OPC was considerable, but the W/C did not strongly influence the diffusion coefficients of LBB.

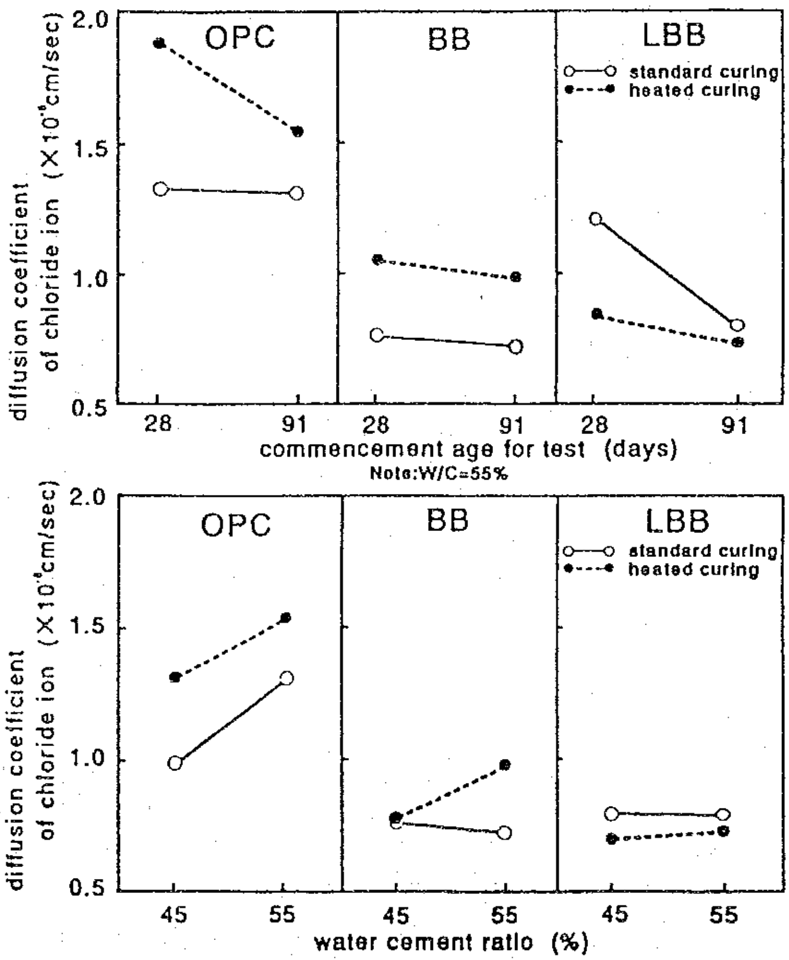
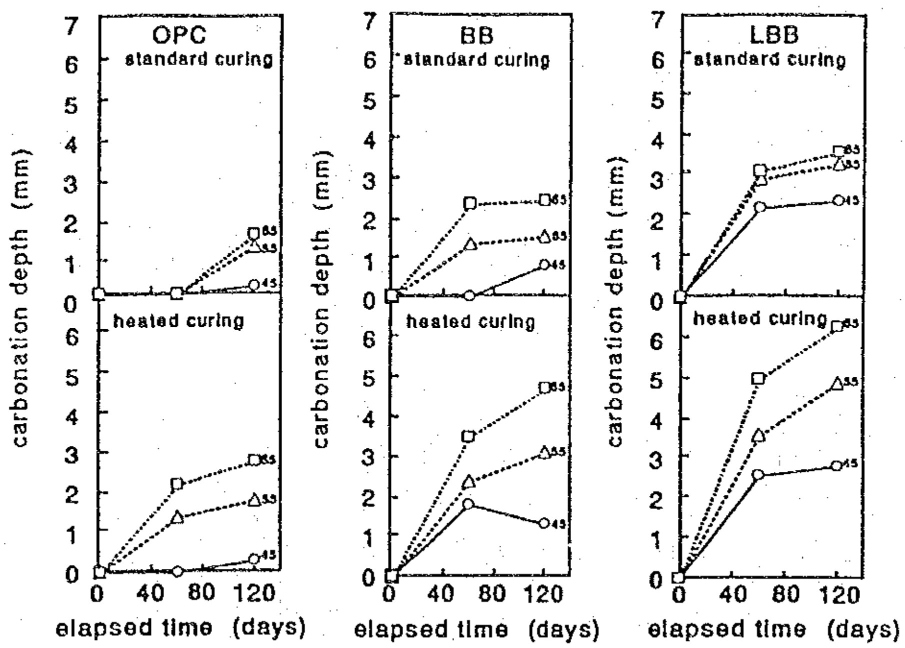


Fig.3 Diffusion coefficient of chloride ion



Note:Numerical values represent W/C
Fig.4 Progress of carbonation depth

4.3 Carbonation depth

Fig.4 shows the progress of carbonation depth in the mortar specimens. It is recognized first that the carbonation of mortar subjected to the heated curing was deeper than those subjected to the standard curing, regardless of cement types and the W/C. However, when the W/C was small, the heated curing did not influence the carbonation depth significantly.

In terms of the type of cement, the carbonation depth was greatest in type LBB, least in OPC with BB in between. It was assumed that the greater carbonation depth in LBB and BB compared with OPC resulted from a decrease of the calcium hydroxides due to its reaction with the blast-furnace slag (Nagataki et al., 1987). The same tendency was also observed in specimens subjected to the heated curing.

Under these experimental conditions, the W/C appeared to be the dominant factor influencing carbonation depth and, when the W/C was increased, the carbonation depth increased. Heated curing tended to increase the carbonation depth.

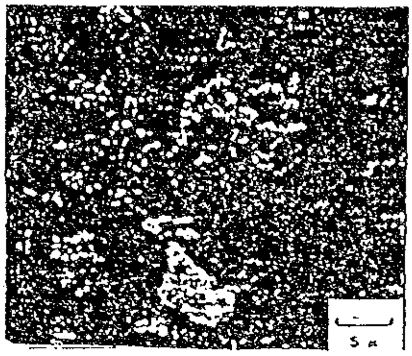
4.4 Microstructure of hardened mortar

(a) Observation by a scanning electron microscope

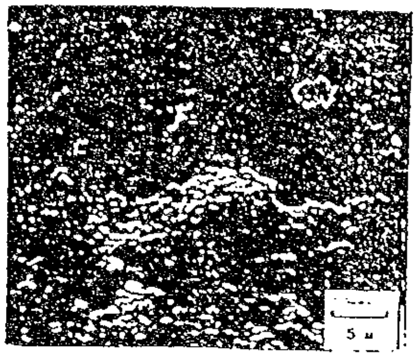
The results of observation are shown in Fig.5. The microstructure of hardened mortar subjected to standard curing became more dense in comparison with heated curing, and this tendency was most noticeable in mortar which included blast-furnace slag.

(b) Pore size distribution

The pore size distribution measured with a mercury intrusion porosimeter are shown in Fig.6. The total pore volume is shown in Table 4.

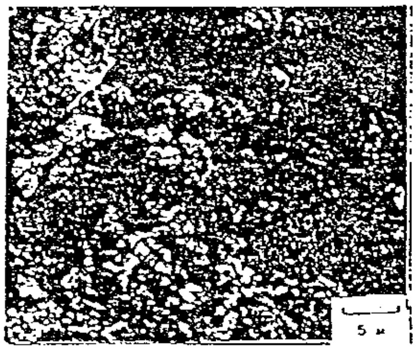


heated curing

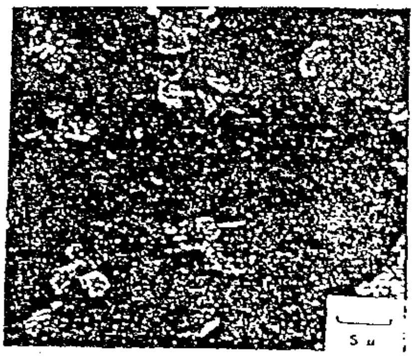


standard curing

(a) OPC



heated curing



standard curing

(b) BB

heated curing

standard curing

(c) LBB

Fig.5 Scanning electron microscope observations (at the age of 91 days)

When the hardened mortars of BB and LBB were subjected to standard curing, smaller pore sizes(7 nm and 24 nm) increased in comparison with OPC. Thus the pore size distribution differed according to the type of cement, however the total pore volume did not differ noticeably regardless of the type of cement.

When temperature history is considered, the pore size distribution is shifted to coarser side, and pore size less than 7 nm decreased notably. Furthermore, the total pore volume of hardened mortar of any cement type increased under heated curing and the density of the microstructure tended to decrease.

Table 4. The total pore volume of hardened mortar (Note:W/C=55%)

Curing condition	Type of cement		
	OPC	BB	LBB
Standard curing	0.0933	0.0868	0.0994
Heated curing	0.1033	0.1181	0.1381

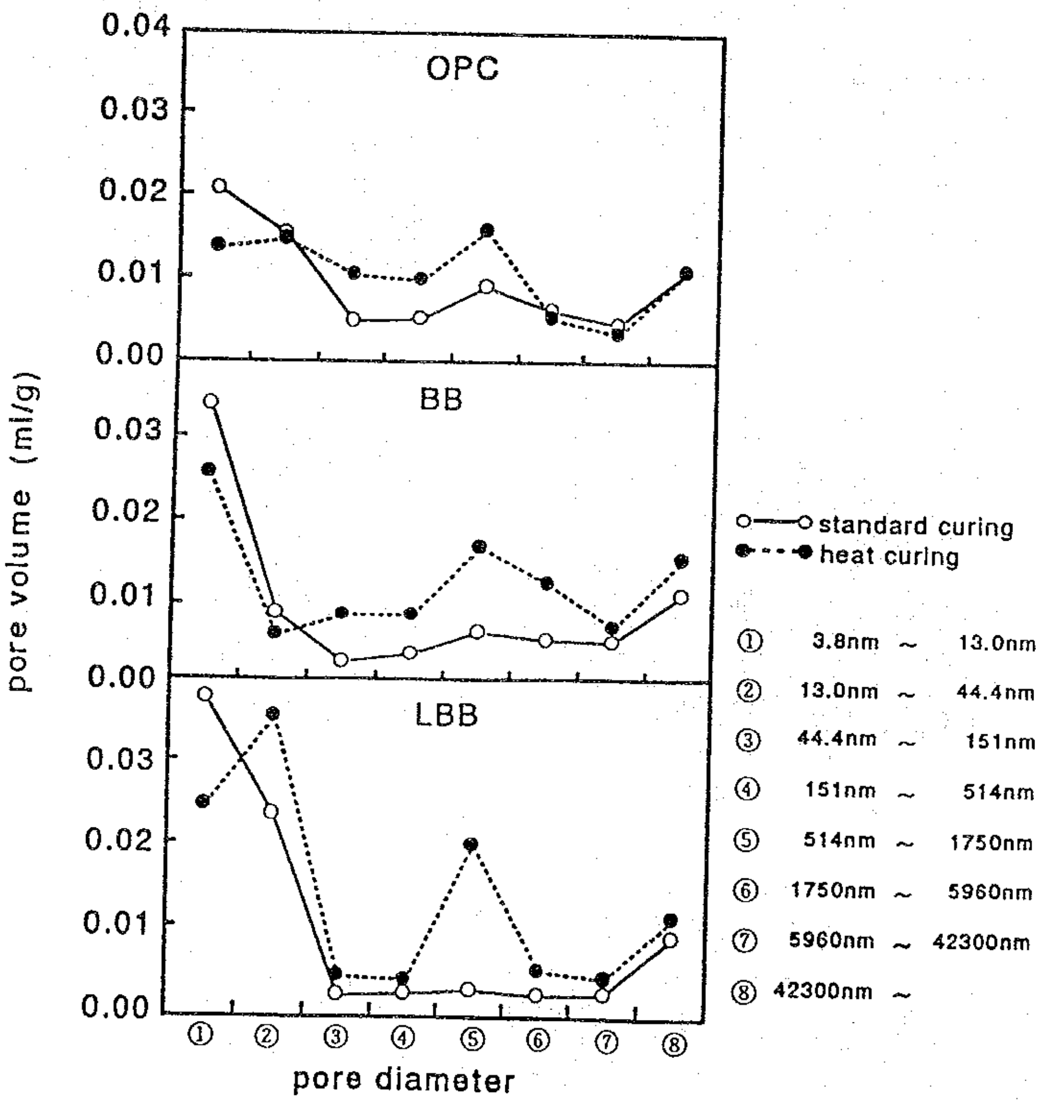


Fig.6 Pore size distribution

(c) Correlation between microstructure and durability
In these experiments, under heated curing the long-term strength development decreased and the rate of carbonation increased in comparison with standard curing, regardless of cement types. Under heated curing, the rate of chloride ion penetration in OPC and BB specimens increased, however it decreased in LBB in comparison to standard curing. This was especially noticeable in OPC specimens.

An examination by scanning electron microscope and mercury intrusion porosimeter indicates that the total pore volume increased and the volume of micro pore size greater than 81 nm also increased. As a result, the density of the microstructure deteriorated when subjected to heated curing. This tendency was recognized regardless of cement types. However, pore size distribution of OPC and BB changed noticeably compared with those of LBB. Accordingly, the inferior quality of hardened mortar subjected to a high temperature history is considered to be due to the change of microstructure of hardened mortar which was caused by the temperature history. However, the rate of chloride ion penetration in LBB decreased under heated curing, and this may be considered to be due to the difference in hydrates of the base cement (Shigeru et al., 1983; Goto, 1987).

5 Conclusions

(1) For OPC, BB and LBB, the compressive strength of specimens subjected to heated curing was larger than those subjected to standard curing at the age of 7 days. However, the subsequent strength development was very small, and the strengths of specimens subjected to heated curing were lower than those subjected to standard curing at the age of 28 and 91 days.
(2) In the cases of OPC and BB, the chloride ion diffusion coefficients of specimens subjected to heated curing were larger than those subjected to standard curing. However, in the case of LBB the opposite tendency was recognized.
(3) The diffusion coefficients of chloride ion in BB and LBB were smaller than those in OPC. The coefficients in BB and LBB specimens subjected to heated curing were also smaller than that of OPC specimens subjected to standard curing. This may be considered to be due to the formation of a dense microstructure which was caused by hydration of cement and slag reaction in BB and LBB and lower temperature rise value of mortar in comparison with OPC.
(4) Carbonation of specimens subjected to the heated curing was deeper in comparison with those subjected to the standard curing. However, when the W/C was relatively small, such as 45%, the heated curing did not affect the carbonation depth significantly.
(5) When the specimens were subjected to heated curing, the pore size distribution was shifted from smaller pore size to larger pore size. In other words, when the specimens were subjected to heated curing, the hardened mortar became more porous.
(6) The counter-measures to prevent thermal cracking in massive concrete are, [1] the reduction of concrete temperature by the use of low heat type cement and the execution of pre-cooling or pipe-cooling, [2] the reduction of temperature gradient inside concrete

which is caused by diffusion of hydration heat by means of insulated curing with a heat insulator. However,it was apprehended that the counter-measure of [2] which retains heat of hydration inside concrete could compromise the quality of massive concrete.

6 Acknowledgments

We received very appropriate advice and support in the performance of experiments and writing of papers, from M. Nishikawa, T. Habuchi & Y. Akiba of Toa Corporation, and from T. Ikabata, K. Horiguchi, T. Chosokabe, H. Takemura, A. Otsuka & R. Rinehart of Sumitomo Cement Co.,Ltd.. We would like to express our deep appreciation to these persons.

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REHABILITATION AND PROTECTION OF MARINE CONCRETE STRUCTURES USING ELECTRODEPOSITION METHOD

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ABSTRACT

Electrodeposits of chemical compounds such as $CaCO_3$ and $Mg(OH)_2$ are precipitated in cracks and voids in marine reinforced concrete structures by feeding a direct current through sea water.

In this paper, a rehabilitation and protection method using this electrodeposition process was established for marine concrete structures.

From a series of laboratory and on-site tests, the following advantages of this method were confirmed:

(1) it can fill and repair concrete cracks;
(2) it can improve quality of concrete, such as permeability; and
(3) it can remove chloride ions around reinforcing steel.

INTRODUCTION

Electrodeposits of chemical compounds such as $CaCO_3$ and $Mg(OH)_2$ are precipitated on cathode metal surface under cathodic protection in sea water. These layers of inorganic compounds are known to provide a physical barrier, and reduce the flux of dissolved oxygen from the bulk solution to the metal surface.

By the way, in light of the recent boom in waterfront development projects, a great deal of attention is being focused on the effects of cracks and concrete permeability on the corrosion protection and performance of marine reinforced concrete structures.

As a result of this concern, investigation into the rehabilitation and protection method by using the electrodeposition process to fill these cracks in concrete with electrodeposits has been carried out over the past few years. In theory, this can be accomplished by feeding a weak direct current between the reinforcing steel (the cathode) in concrete structures and an electrode (the anode) located under sea water (see Fig. 1). As concrete itself is a conductor, a hard layer of electrodeposits is formed on the submerged surface of the concrete structures.

In this paper, the authors have discussed the effectiveness of electrodeposition method as a means of rehabilitation and protection of marine concrete structures, as well as the effects of the application of the electrodepositing current on the concrete-reinforcement bond strength. Mainly, our evaluations of the electrodeposition method were based on the results of on-site tests conducted on a wharf caisson. A series of laboratory tests was also carried out to explain some of the basic characteristics of the electrodeposition method when applied to marine concrete structures.

OUTLINE OF EXPERIMENT

For the laboratory tests, three different types of cylindrical reinforced concrete specimens were prepared. A crack of 1 mm in width was induced from concrete surface to reinforcing steel in some specimens, which simulated concrete deteriorated in marine environments (see Fig. 2). The mix proportion of concrete for these specimens is given in column A in Table 1. After curing in water for 28 days, the top and bottom of the specimens were coated with epoxy resin. Then they were placed in a tank of sea water and given an electric charge of 0–0.9 A/m^2 (based on the surface area of exposed concrete) for 1–3 months. After the test periods, the specimens were tested and evaluated for (a) growth appearance of electrodeposits on the concrete surface and in cracks, (b) chloride content in concrete, and (c) permeability of concrete.

Table 1. Mix proportion of concrete test specimens

Mix types(1)	A	B	C	D
G_{max} (cm)	20	20	20	20
W/C (%)	75	55	55	54
S/A (%)	53	45	45	45
Units (kg/m^3)				
Water	210	174	174	166
Cement(2)	280	317	317	310
Sand(3)	906	783	783	773
Gravel(4)	809	983	983	1021
Admixture	(5)	(6)	(6)	(7)
NaCl	0	0	3	3
Slump (cm)	16.0	8.6	7.9	8.0
Air (%)	5.0	4.3	4.7	4.2
Compressive strength (kgf/cm^2)	198	428	361	346

Note (1) Laboratory tests – Mix type A;
Field tests – Mix type B;
Bond strength test – Mix type B, C, D.
(2) Ordinary portland cement.
(3) Crushed sand.
(4) Crushed gravel.
(5) Air-entraining admixture.
(6) Water-reducing admixture.
(7) Air-entraining admixture, water reducing admixture.

On-site tests were conducted on a 25-year-old RC wharf caisson (W x D x H = 4 x 8 x 9 m) in the Port of Matsuyama, Shikoku Island. The degree of deterioration of the caisson in the splash zone was judged to be at level IV (many cracks of width exceeding several millimeters), while that in the tidal zone was judged to be at level II (several cracks). A direct current was fed for five months by power supply between the caisson and two anodes placed on the seabed on both sides of the caisson. Current voltage was set so that the current density would be maintained at 0.5 A/m^2 at mean water level. After the test period, the caisson was tested and evaluated for (a) growth appearance of electrodeposits on the surface and cracked section of the caisson, (b) chloride content in the caisson concrete, (c) permeability of the electrodeposited concrete, and (d) pore size distribution of electrodeposits and concrete (pore volume).

Other field tests were also carried out using two 700 x 1000 x 200 mm (W x L x T) reinforced concrete test specimens with D13 reinforcing steel placed at a pitch of 100 mm (see column B in Table 1 for mix proportion). The specimens were wet-cured for 28 days prior to testing. After curing, a direct current of 0.65 A/m^2 was applied to one specimen for a period of 96 days. These specimens were then submerged in sea water for one year. After completion of the test period, the specimens were tested and evaluated for (a) growth appearance of electrodeposits, (b) chloride content in the concrete, (c) permeability of electrodeposited concrete, and (d) the adhesion strength of the electrodeposits to concrete.

Finally, another series of tests was carried out to examine the influence of the electrodepositing current on the bond strength between the reinforcing steel and the concrete. Two types of cylindrical reinforced concrete specimens of ϕ 150 x 150 mm (see Fig. 3) were made for these tests, one containing 3 kg/m^3 of NaCl and one containing no additives (see column B, C, D in Table 1 for mix proportion). Five different current densities between 0 and 2 A/m^2 (based on the surface area of concrete, 0 and 4.4 A/m^2 based on the surface area of reinforcing steel) were applied to the specimens for a period of 1–4 months. The bond strength tests were carried out in accordance with the the Japan Society of Civil Engineer's standards.

RESULTS AND DISCUSSION

Growth appearance of electrodeposits

Figure 4 shows the growth appearance of electrodeposits on the concrete surface and in a crack. In non-cracked specimens, electrodeposition developed uniformly on the concrete surface (Fig. 4(a)). Spotty distribution of electrdeposits found on the specimens was due to that electrodepositing occurring in micro-pores of concrete. However, by a cross-sectional investigation of the specimens, it became clear that all concrete surfaces had been coated with a layer of electrodeposits. While in crack-induced specimens, it grew around the cracks (Fig. 4(b)), and had even penetrated deep into the crack.

Figure 5 indicates the relationship between current density (in regard to concrete surface area) and the weight gain of electrodeposit per squre meter per day. Figure 6 indicates the relationship between current density and the chemical composition of electrodeposits in terms of weight ratio of $CaCO_3/Mg(OH)_2$ (Ca/Mg ratio). The results indicated that the weight gain of electrodeposits increased with the increase in current density, while the Ca/Mg ratio became smaller. And the weight gain of electrodeposits is almost directly proportional to the total applied current (ampere hours square meter) according to Faraday's Law. The strength of the electrodeposits increased with the increase in the Ca/Mg ratio. As shown in Table 2, the compressive strength of the electrodeposits with a Ca/Mg ratio of 1.5 stood at 60–200 kgf/cm^2, while the bending strength of the same deposits was measured to be 50–70 kgf/cm^2, indicating the deposits were of a similar strength to normal concrete.

Table 2. Properties of electrodeposit and concrete

Property	Electrodeposits	Concrete
Specific gravity	2.5	2.8
Bulk specific gravity	2.1	2.4
Vickers hardness	100–200	–
Compressive strength (kgf/cm^2)	60–200	200–500
Bending strength (kgf/cm^2)	50–70	30–60
Thermal conductivity (kcal/nh°C)	1.18	1.3
Young's modulus (kg/cm^2)	2 x 10^5	3 x 10^5

Note: Chemical composition of electrodeposits: $CaCO_3$ 52.5%, $Mg(OH)_2$ 35.7%, Ca/Mg ratio 1.5.

Application of an electrical charge to the test caisson for five months resulted in a 0.5–2 mm thick electrodeposits layer with a Ca/Mg ratio of 1.7 on the concrete surface. Shortly after application of the charge it was confirmed that all cracked areas had been filled with electrodeposits, which Ca/Mg ratio was as low as 0.23. Figure 7 shows the appearance of electrodeposits in cracks in the reinforced concrete beam of the caisson. The reason for the high proportion of Mg in these electrodeposits is a higher degree of current density around the cracks caused by a lower degree of electrical resistance.

Chloride removal

Tests were carried out to examine the effectiveness of electrodeposition method as a means of removing chloride ions from salt-contaminated marine concrete structures. Evaluation tests were carried out by taking concrete core samples from the part of the caisson submerged under 0.3 m of low water level. Chloride content was measured according to the Japan Concrete Institute's method. Figure 8 indicates the distribution of chloride content in the samples as was measured before current application, after three, and five month's application. Samples taken before current application showed the surface of the caisson to have extremely high level of chloride content. Then it gradually decreased with the depth from the surface, indicating that a large amount of chloride ions had penetrated from the sea water into the caisson after its construction. However, it was confirmed that chloride ions could be removed from the caisson by applying a negative charge to the reinforcing steel. After five months continuous charging, about 50% decrease in the chloride content was observed around the reinforcing steels, and 60% decrease in the concrete of the depth interval 0 to 11 cm from surface. This phenomena seems that negatively charged chloride ions were removed toward the anode in the sea.

Chloride penetration

Some tests were conducted to examine the effect of using electrodeposition method as a means of reducing chloride ions penetration from sea water into the marine concrete structures. Figure 9 indicates the chloride distribution in electrodeposited specimen and non-charged specimen. Measurement for electrodeposited specimens were carried out after 96 days of charging, as well as one year after charging termination. Samples taken from the non-charged specimen indicated a high concentration of salt on the surface (0.46 wt%) and traces of penetration at the depth of 70 mm from the surface. In the case of the charged specimen, however, traces of penetration were detected up until 30 mm from the surface, while the surface concentration stood at 0.12 wt%, which is about 1/4–1/5 of the level of the non-charged specimen. Judging from the above results, the authors were able to conclude that electrodeposition helped to greatly reduce the amount of chloride penetration, and that the electrodeposits continued to help retard absorption even after charging termination.

Concrete permeability

Permeability tests were conducted to examine the watertightness of the electrodeposited concrete. Figure 10 indicates the relationship between total applied current and coefficients of permeability of electrodeposited concrete. The figure indicates the results for the laboratory tests, field tests (using test specimens) and on-site tests on the caisson. All plotted values are averages of 2–3 data.

Permeability tests of the caisson concrete were carried out by concrete core samples taken from the part of the caisson. Coefficients of permeability were obtained by measuring the volume of pressurised water percolating through circular plate-shaped test pieces of ϕ 100 x 20 mm. Coefficients of permeability decreased with the increase in total applied current, and stood at 3×10^{11} cm/s for 3000 A•hr/m^2 (after 5 months charging) which is about 1/40 of the original value. Such a low permeability is equal to that of high quality concrete.

Pore size distribution

A mercury intrusion porosity meter was used to evaluate the pore structure for the concrete and electrodeposits. Figure 11 shows typical readings as recorded in the tests. Observation of the concrete pore size distribution pattern reveals that the total pore volume is 90 mm^3/g, and that 50-percentile pore radius is approximately 400Å. This contrasts sharply with the extremely fine structure of the electrodeposits, which were measured to contain 70 mm^3/g of pore volume, of which 50-percentile pore radius of 150Å. From these results, it was concluded that the improvement of permeability and chloride penetration of concrete were due to the dense layer of electrodeposits on the concrete surface.

Adhesive strength

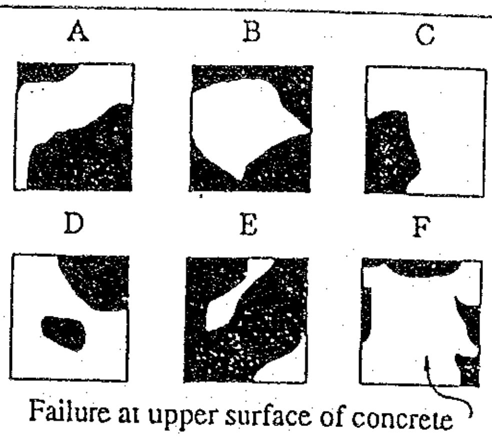
An adhesive strength between electrodeposit and concrete was measured on the field test specimen (see Table 3), on which the Ca/Mg ratio of the electrodeposits stood at 1.5–2.0. As a results of the tests, the adhesive strength was calculated to be appoximately 26.5 kgf/cm^2, which is equal to splitting tensile strength of surface concrete. This shows that the adhesion of the electrodeposits to concrete is very high.

Bond strength

Figure 12 indicates the relationship between total applied current (based on the surface area of reinforcement) and the maximum bond strength of the reinforcement under electrodeposition process. Several studies have been carried out on the effect of a direct current on the bond strength of steel in concrete. Some of them have shown that the bond strength decreased if the reinforcing itself is given a direct current negative charge. However, no significant reduction was detected for charges of 1500–6500 A•hr/m^2 in this study. Results showed that the maximum bond strength of charged specimens without NaCl was equal to 90% of the strength of non-charged specimens, and that the maximum bond strength of charged specimens with NaCl, 3 kg/m^3, was almost the same as that of non-charged specimens.

Table 3. Results of adhesive strength test

Specimen	Adhesive strength (kgf/cm^2)	P (%)	Failure condition
A	27.8	45	
B	27.8	44	
C	30.0	70	
D	26.3	67	
E	28.1	13	
F	18.8	73	
Average	26.5	52	



Note: The attachment measured 40 x 40 mm
P represents the percentage of surface area that broke away at the upper surface of the concrete.

CONCLUSION

As a result of the laboratory and on-site tests, the following conclusions were made regarding the advantages of the electrodeposition method as a means of rehabilitation and protection of marine concrete structures:

(1) Electrodeposits tend to be more precipitated in and around cracks and other places of higher conductivity.
(2) By applying a negative charge to the reinforcing steel in concrete structures, chloride ions could be removed from the salt-contaminated concrete.
(3) From the pore size distribution test, it was found that pore structure of electrodeposits was a lot denser than that of concrete.
(4) Electrodeposits on the concrete surface help to increase the concrete watertightness, as well as reduce the chloride penetration from the sea water into the concrete even after charging has been terminated.
(5) The adhesive strength of the electrodeposits to concrete is equal to splitting tensile strength of surface concrete.
(6) No significant reduction was detected on the bond strength of steel in concrete under the electrodeposition process.

ACKNOWLEDGMENTS

The authors are grateful to The 3rd District Port Construction Bureau and Port and Harbours of Ehime Prefecture for on-site tests on the wharf caisson. Further, Shikoku Research Institute Inc. (SRI) is grateful to Shikoku Electric Power Co., Inc. (SEPCO) for its generous financial support for this study.

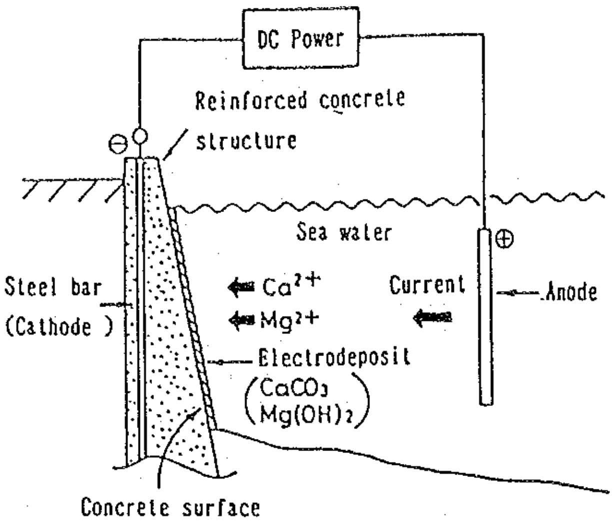


Figure 1. Principle of the electrodeposition method.

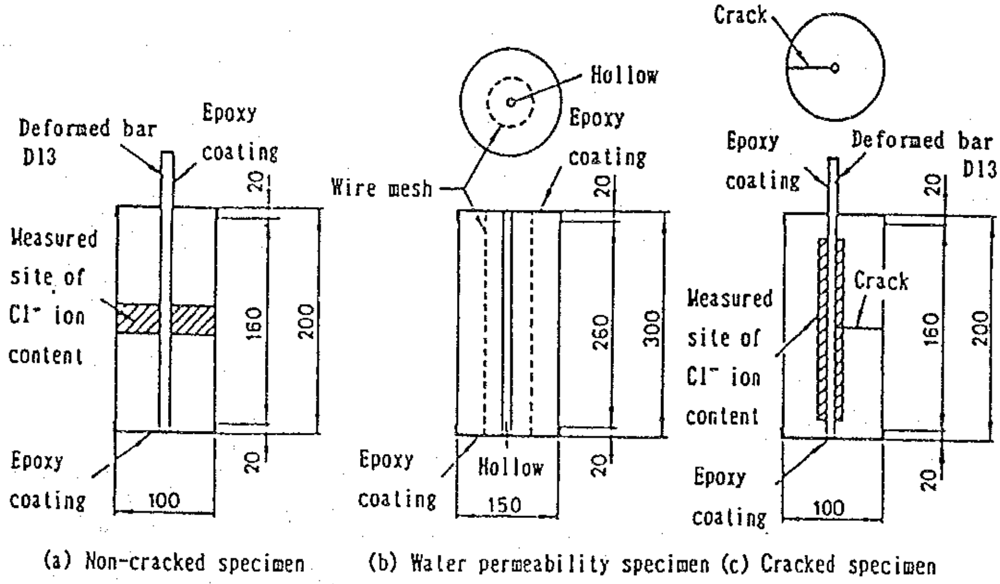


Figure 2. The specimens for the laboratory tests.

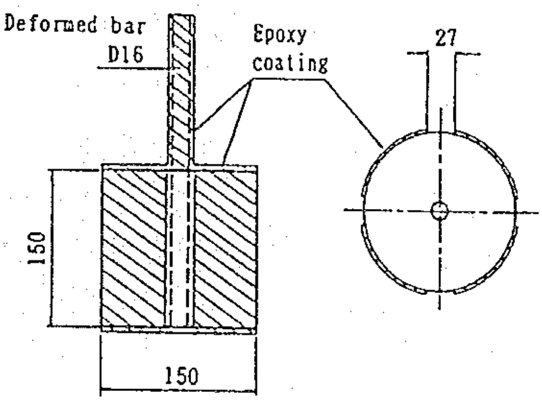


Figure 3. The specimens for the bond strength tests.

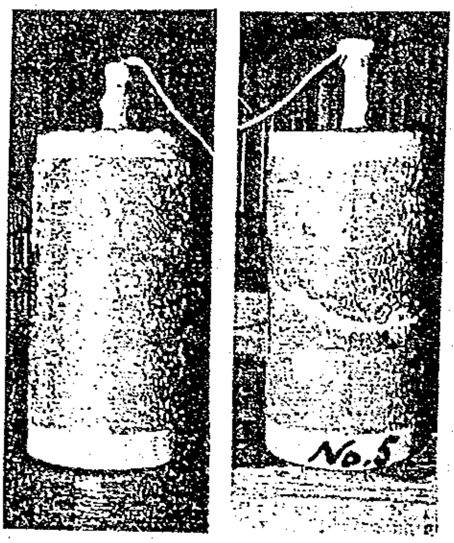


Figure 4. Appearance of electrodeposits: (a) non-cracked specimen; and (b) crack-induced specimen.

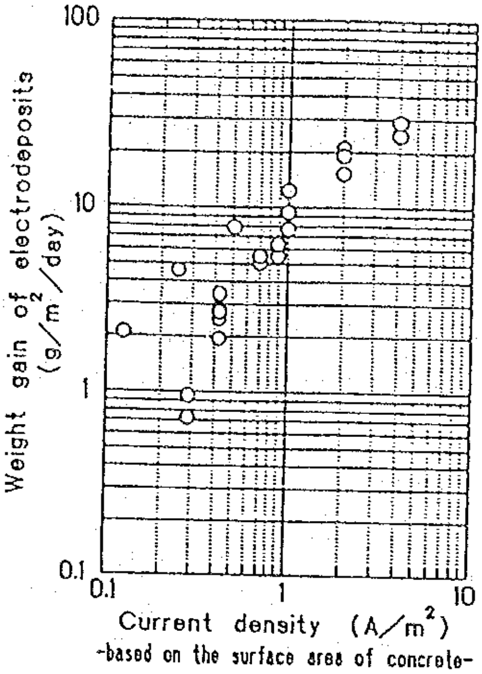


Figure 5. Relationship between current density and weight gain of electrodeposits.

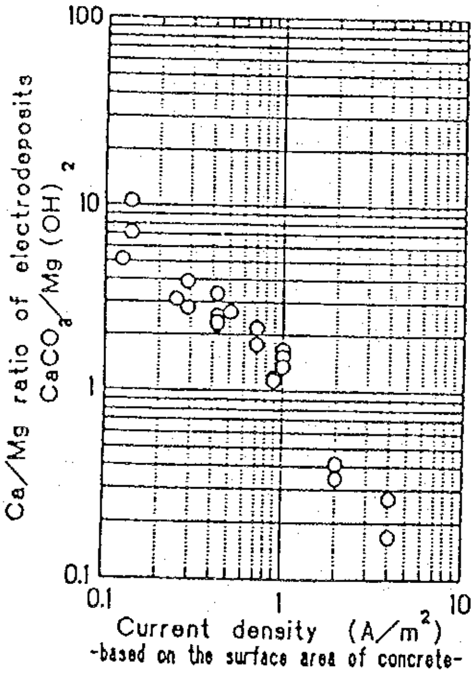


Figure 6. Relationship between current density and the chemical composition of electrodeposits.

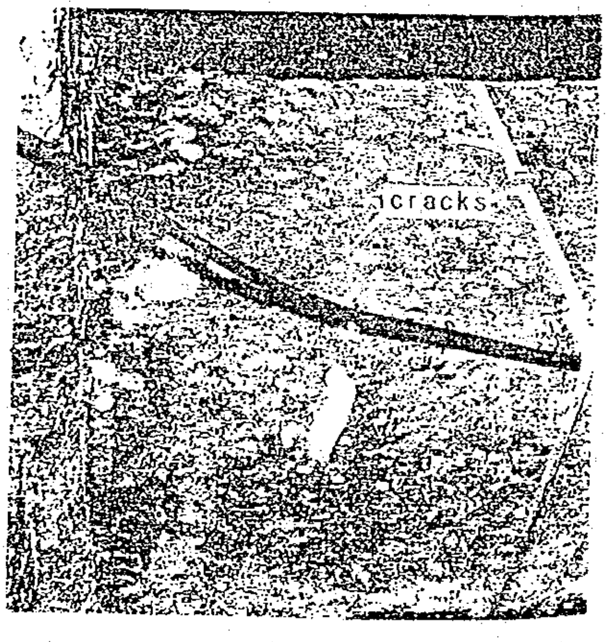


Figure 7. Appearance of electrodeposits in cracks of a reinforced concrete beam of the caisson.

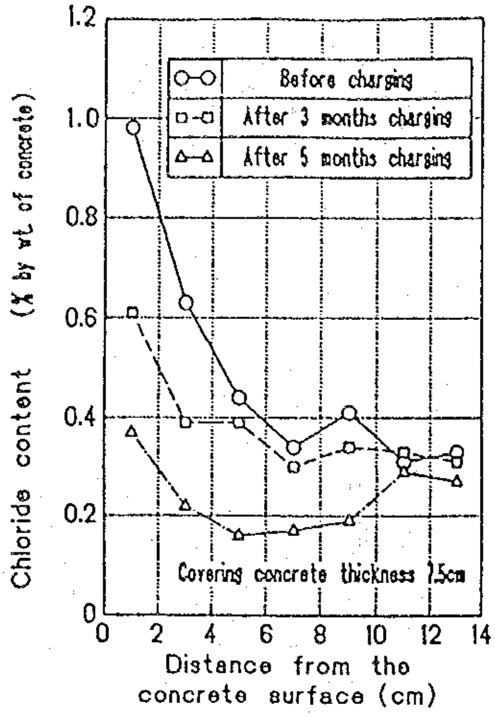


Figure 8. Distribution of chloride content in the caisson concrete under the electrodeposition method.

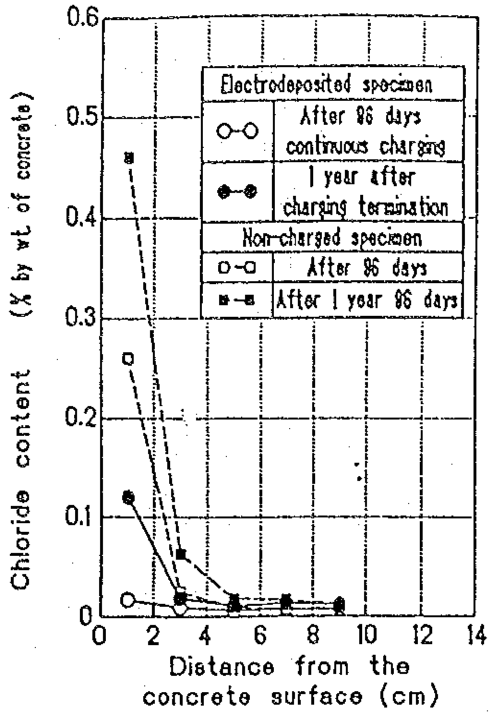


Figure 9. Effect of the electrodeposits on the chloride penetration from sea water into the concrete.

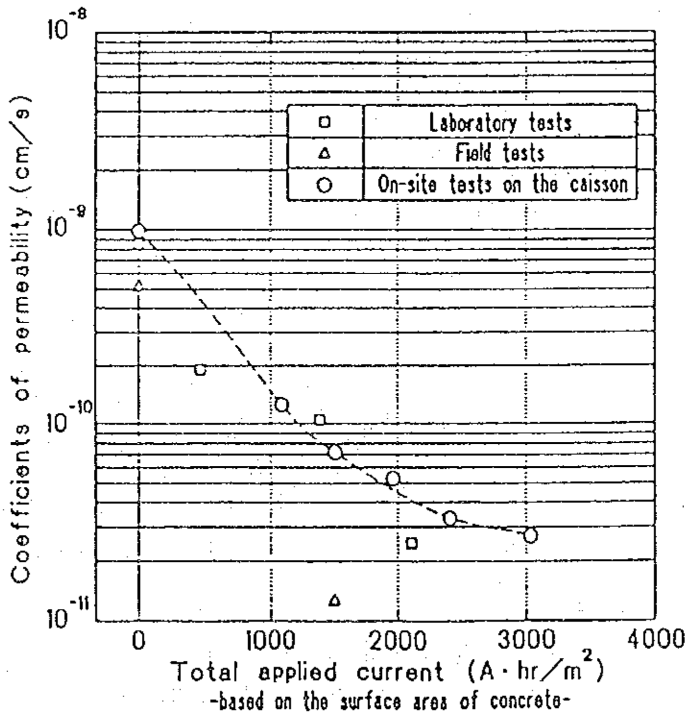


Figure 10. Relationship between total applied current and permeability coefficients of electrodeposited concrete.

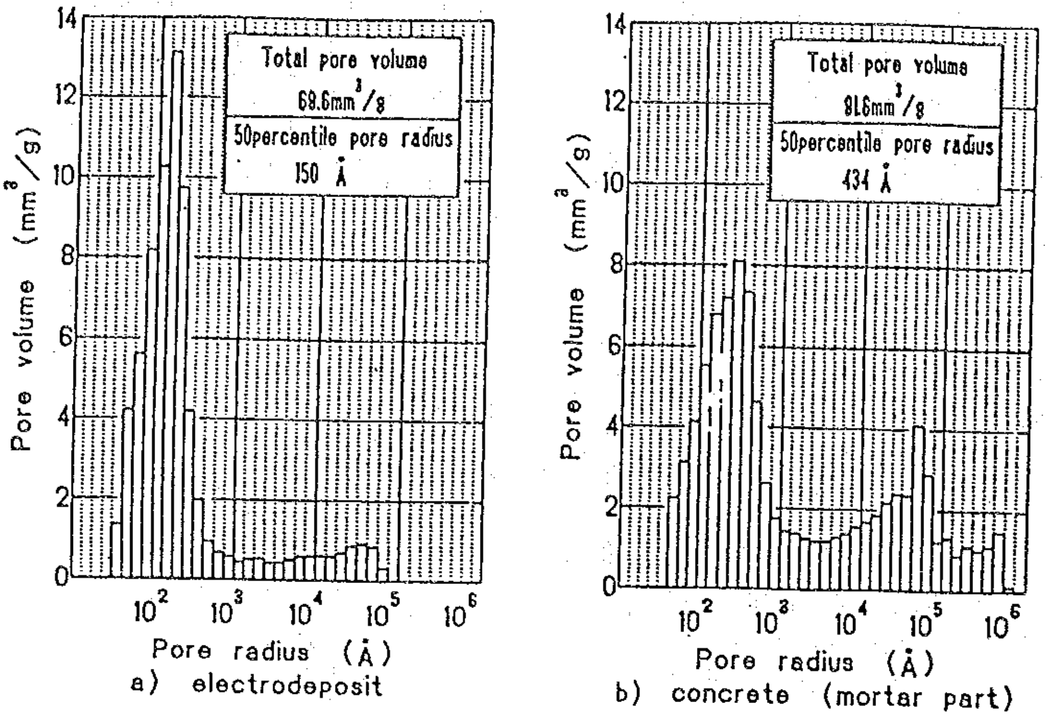


Figure 11. Pore size distribution for concrete and electrodeposits.

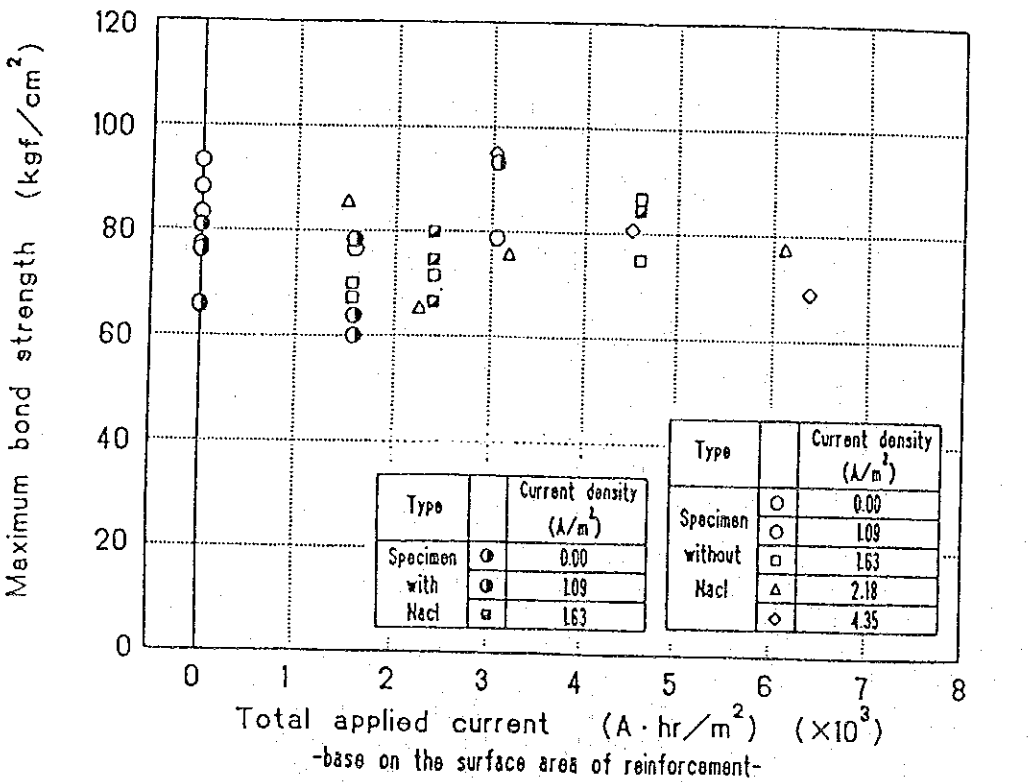


Figure 12. Relationship between total applied current and the maximum bond strength under electrodeposition method.

4. 当該訪問国機関に提出した英文所見

(1) インドネシア

Jakarta, September 24, 1993

Dear Sir;

It is my great pleasure to submit the summary report of the Follow-up Team for Ex-participants of Group Training Course in Port and Harbour Engineering II.

The team, which was dispatched by the Japan International Cooperation Agency as a part of its technical follow-up programme for ex-participants, and consist of four members as mentioned in the report, arrived in Indonesia on September 20, 1993. Through the visit of this time, we could obtain many valuable comments and suggestions about the above-mentioned group training course from the competent authorities concerned and also from the ex-participants and other people around them. We are quite sure that the information we acquired should be greatly useful for the purpose of improving the course and also the entire technical cooperation programme.

Finally, I would like to express my heartiest appreciation for your warm hospitality and kind cooperation extended to us during our stay in your country.

Yours faithfully,

Tsutomu FUKUTE,

Team Leader

SUMMARY REPORT

BY

THE FOLLOW-UP TEAM FOR THE EX-PARTICIPANTS

OF THE JICA GROUP TRAINING COURSE

IN

PORT AND HARBOUR ENGINEERING II

SEPTEMBER 1993

INDEX

I. OBJECTIVE

The Follow-up Team will visit ex-participants, their organizations and related organizations for the purpose of:

i) researching the overall sector of this training field in the countries the team will visit, thus contributing to identification of problems and needs ex-participants may now have in their daily execution of work.

ii) holding the Open Technical Seminar in the field of port and harbours engineering for the ex-participants and the experts in this field to introduce the latest knowledge and technologies,

II. PERIOD

From September 20 to 25, 1993

III. MEMBERS

(1) Dr.Tsutomu FUKUTE (Team Leader)

Chief of Materials Laboratory,

Structural Engineering Division,

Port and Harbour Research Institute,

Ministry of Transport

(2) Mr.Keita FURUKAWA (Technical Instructor)

Researcher, Purification Hydraulics Laboratory,

Marine Hydrodynamics Division,

Port and Harbour Research Institute,

Ministry of Transport

(3) Mr.Yasunori MAKITA (Technical Instructor)

International Cooperation Section Chief,

International Affairs Office,

Ports and Harbous Bureau,

Ministry of Transport

(4) Ms.Kiyoko KANI (Planner & Coordinator)

Staff,

Second Training Division,

Tokyo International Centre,

Japan International Cooperation Agency

IV. SCHEDULE OF THE FOLLOW-UP TEAM

1. Sept.20(Mon.) Lv. Tokyo (11:00) GA-873
   Ar. Jakarta (16:25)

2. 21(Tue.) ・Visit to JICA office for arrangement of the schedule
   ・Courtesy Call to the Embassy of Japan
   ・Courtesy Call to SEKKAB Office
   ・Visit to Directorate General of Sea Communication

3. 22(Wed.) ・Visit to Public Port Corporation Second
   ・Visit to the Port of TJ.Priok
   ・Visit to the Agency for the Assessment and Application of Technology

4. 23(Thu.) ・Open Technical Seminar (on the first day)

5. 24(Fri.) ・Report to the Embassy of Japan and JICA office
   ・Collection of data and Report Making

6. 25(Sat.) ・Meeting in the Team
   Lv. Jakarta (17:20) TG-414
   Ar. Bangkok (21:50)

V. SEMINAR AGENDA

09:00 - 09:30 REGISTRATION

09:30 - 10:00 OPENING CEREMONY

-OPENING ADDRESS BY DR.FUKUTE, THE TEAM LEADER

-ADDRESS BY THE REPRESENTATIVE OF RELEVANT AUTHORITY

(MR.SUDJANADI,DIRECTOR OF PORTS AND DREDGING, DGSC,MOC.)

10:00 - 10:30 OUTLINE OF JICA ACTIVITY BY MS.KANI, JICA

10:30 - 11:30 LECTURE BY MR.MAKITA, MOT.

-JAPANESE INTERNATIONAL COOPERATION POLICY IN THE FIELD OF PORTS AND HARBOURS.

-RECENT TECHNOLOGICAL TREND ON PORTS AND HARBOURS ENGINEERING IN JAPAN.

11:30 - 12:50 LUNCHEON HOSTED BY THE TEAM LEADER AT PRESIDENT HOTEL

12:50 - 13:50 LECTURE BY DR.FUKUTE, PHRI

-OVERAGE OF PORT FACILITIES.

13:50 - 14:50 LECTURE BY MR.FURUKAWA, PHRI

-ENVIRONMENTAL PRESERVATION AND COASTAL DEVELOPMENT.

14:50 - 15:00 COFFEE BREAK

15:00 - 15:40 REPORT BY AN EX-PARTICIPANT

MR.SYAMSURIZAL,STAFF OF SUB DIRECTORATE OF PLANNING,

PUBLIC PORT COOPERATION II

-PRESENT PROBLEMS ON MAINTENANCE OF PORT FACILITIES IN INDONESIA

15:40 - 16:10 REPORT BY MR.HAYASHI, JICA EXPERT

-THE PROCESS OF PORT DEVELOPMENT AND SOME PROBLEMS IN INDONESIA

16:10 - 16:50 DISCUSSION

16:50 - 17:00 CLOSING CEREMONY

VI. PERSONNEL IN INDONESIA WHOM THE TEAM MET

(1) SEKKAB (CABINET SECRETARIAT OF THE REPUBLIC OF INDONESIA)

MR. HUSEN ADWISASTRA, HEAD OF BILATERAL COOPERATION DIVISION

MR. KIAGUS USMAN, HEAD SUB DIVISION OF COOMBO PLAN FELLOWSHIPS

(1) DIRECTORATE GENERAL OF SEA COMMUNICATION

MR. SUDJANADI, DIRECTOR OF PORTS AND DREDGING

(2) INDONESIA PUBLIC PORT CORPORATION 2

MR. SUPRIHAT, HEAD OF CIVIL ENGINEERING SUB DIVISION

MR. SYAMSL RIZAL, STAFF OF SUB DIVISION OF PLANNING

MR. ZAINUL ARIFIN DJAYAPUTRA

MR. A. BASIR SUMIRAT, STAFF OF CIVIL ENGINEERING SUB DIVISION

MS. JUSNI EDISON, CHIEF OF TECHNICAL AND PLANNING SECTION

MS. NUR AFNI

MR. KUSMIJASI

(3) AGENCY FOR ASSESSMENT AND APPLICATION OF TECHNOLOGY (BPPT)

PROF. SURYONO, CHAIRMAN DEVELOPMENT FOR COASTAL ENGINEERING LABORATORIUM

MR. DINAR C. ISTIYANTO, RESEARCHER

MS. NOVI IRAWATI

VII. SUMMARY OF THE FINDINGS AND IMPRESSION OF THE TEAM

1. SEKKAB (CABINET SECRETARIAT OF THE REPUBLIC OF INDONESIA)

AT THE SEKKAB WE HEARD THAT THE COUSE IN PORT AND HARBOUR ENGINEERING WAS VERY USEFUL AND MANY AUTHORITIES AND ORGANIZATIONS ARE INTERESTED IN THIS COURSE. CONSIDERING THIS SITUATION, THEY MENTIONED WHETHER IT IS POSSIBLE TO ACCEPT SOME MORE PARTICIPANTS FORM INDONESIA FOR EACH YEAR. OUR COMMENT UPON THIS POINT IS THAT OUR BUDGET IS LIMITED NOW AND THERE ARE STILL MANY COUNTRIES THAT ARE INSTERESTED IN THIS COURSE, SO FAR WE CANNOT ACCEPT THE PARTICIPANTS MORE THAN ONE PARTICIPANT PER ONE COUNTRY EACH YEAR.

2. DIRECTORATE GENERAL OF SEA COMMUNICATION

AT DGSC, WE HEARD ABOUT THE TECHNICAL PROBLEM IN THE INDONESIAN PORTS. THEY MENTIONED THAT THEY HAVE THE PROBLEM ON THE BELOW MENTIONED THREE POINTS. 1. DESIGN STANDARD, 2. HYDRAULICS, 3. METHDOLOGY OF THE ADMINISTRATION AND MANAGEMENT OF PORTS AND HARBOURS.

3. PUBLIC PORT CORPORATION 2

WHAT WE MUST TAKE NOTES IN THE INTERVIEW WITH THIS PUBLIC PORT CORPORATION 2 IS THEY ARE VERY INTERESTED IN THE ENVIRONMENTAL PROBLEMS. WE HAD LONG TIME TO DISCUSS THIS TOPIC. HERE ALSO THEY MENTIONED THAT SOMETIMES WE ACCEPTED SOME PARTICIPANTS IN THE SAME COURSE FROM ONE COUNTRY, SO THEY FELT IT NOT SO FAIR,IF IT WAS POSSIBLE, THEY WANTED US TO ACCEPT US MORE PARTICIPANTS. WE EXPLAINED IN THE SAME WAY, AND FUTHERMORE, WE ALSO EXPLAINED AS BEFORE, RECENTLY WE STRICTLY KEEP THE PRINCIPLE OF ONE PARTICIPANT FROM ONE COUNTRY. AFTER THE MEETING, WE ALSO HAVE OBSERVED THE CONTAINER YARDS, AND WE ARE VERY SURPRISED THAT THE WATER POLLUTION IS SERIOUS IN THIS AREA. WE ALSO FOUND THAT THE FACILITIES ARE MORE RIGID THAN WE IMAGINED.

4. BPPT(AGENCY FOR ASSESSMENT AND APPLICATION OF TECHNOLOGY)

COASTAL ENGINEERING LABORATORY

THIS ORGANIZATION IS SIMILAR ORGANIZATION WITH THE PORT AND HARBOUR RESEARCH INSTITUTE. WE HAVE NO PARTICIPANT FROM THIS ORGANIZATION. BUT THEY ARE ALSO INTERESTED IN THIS COURSE, SO WE HAD CHANCE TO SEE THEM. THEY ARE GOING ON EXPERIMENTS ONLY CONCERNED WITH THE COASTAL MATTERS, SO WE THOUGHT THAT IT IS BETTER FOR THEM TO BE TRAINED AS AN EXPERT OF THE COASTAL PROBLEMS RATHER BEING PARTICIPATED IN THE GENERAL COURSE LIKE THIS PORT AND HARBOUR ENGINEERING COURSE. THEY SUGGESTED OUR COURSE SHOULD INCLUDE MORE LECTURES ON NUMERICAL SIMURATION, AND ALSO SUGGESTED TO PROVIDE THE SOFTWARE AND HARDWARE SIMULTENEOUSLY. AS OUR IMPRESSION, THEY ARE SUFFICIENT WITH THE COMPETENT OFFICIALS, SO WE HOPE THAT THE ORGANIZATION SHOULD BE DEVELOPED FUTHERMORE.

5. CONCLUSION

WITHIN THE LIMITATION OF TIME, WE MUST VISIT ONLY A FEW ORGANIZATION THAT ARE CONCERNED, BUT EVERYWHERE WE VISIT, THEY ACCEPTED US WARMLY AND WE THOUGHT THAT ALL OF THEM ARE VERY EAGER IN PARTICIPATING THE COURSE, SO IF WE COULD INCREASE THE NUMBER OF THE PARTICIPANTS FROM INDONESIA, IT WOULD BE VERY HELPFUL TO THEM AND THEY WOULD APPRECIATE THAT. AT THE OPEN TECHNICAL SEMINAR, MANY PEOPLE MORE THAN WE ARE EXPECTED ATTEND IN THE SEMINAR. WE DISCUSSED ABOUT EACH OF THE PROBLEM AND THE QUESTION THAT WE CAN'T ANSWER IMMEDIATELY, WE PROMISED TO ANSWER AFTER WE RETURN TO JAPAN. AFTER GOING BACK TO JAPAN, WE WILL MAKE REPORTS ON THESE INTERVIEW AND SEMINAR, THE PROBLEMS AND THEIR SOLUTION.

(2) タイ

Bangkok, September 30, 1993

Dear Sir;

It is my great pleasure to submit the summary report of the Follow-up Team for Ex-participants of Group Training Course in Port and Harbour Engineering II.

The team, which was dispatched by the Japan International Cooperation Agency as a part of its technical follow-up programme for ex-participants, and consist of four members as mentioned in the report, arrived in Thailand on September 25, 1993. Through the visit of this time, we could obtain many valuable comments and suggestions about the above-mentioned group training course from the competent authorities concerned and also from the ex-participants and other people around them. We are quite sure that the information we acquired should be greatly useful for the purpose of improving the course and also the entire technical cooperation programme.

Finally, I would like to express my heartiest appreciation for your warm hospitality and kind cooperation extended to us during our stay in your country.

Yours faithfully,

Tsutomu FUKUTE,

Team Leader

SUMMARY REPORT

BY

THE FOLLOW-UP TEAM FOR THE EX-PARTICIPANTS

OF THE JICA GROUP TRAINING COURSE

IN

PORT AND HARBOUR ENGINEERING Ⅱ

SEPTEMBER 1993

INDEX

Ⅰ. OBJECTIVE

Ⅱ. PERIOD

Ⅲ. TEAM MEMBERS

Ⅳ. SCHEDULE OF THE FOLLOW-UP TEAM

Ⅴ. THE SEMINAR AGENDA

Ⅵ. PERSONNEL IN INDONESIA WHOM THE TEAM MET

Ⅶ. SUMMARY OF THE FINDINGS AND IMPRESSION OF THE TEAM

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II . PERIOD

From September 25 to October 1, 1993

III. MEMBERS

(1) Dr.Tsutomu FUKUTE (Team Leader)

Chief of Materials Laboratory,
Structural Engineering Division,
Port and Harbour Research Institute,
Ministry of Transport

(2) Mr.Keita FURUKAWA (Technical Instructor)

Researcher, Purification Hydraulics Laboratory,
Marine Hydrodynamics Division,
Port and Harbour Research Institute,
Ministry of Transport

(3) Mr.Yasunori MAKITA (Technical Instructor)

International Cooperation Section Chief,
International Affairs Office,
Ports and Harbous Bureau,
Ministry of Transport

(4) Ms.Kiyoko KANI (Planner & Coordinator)

Staff,
Second Training Division,
Tokyo International Centre,
Japan International Cooperation Agency

IV. SCHEDULE OF THE FOLLOW-UP TEAM

Sep. 25, 1993 (Sat.)	21:50	Mission arrives in Bangkok by TG 414
Sep. 26, 1993 (Sun.)		Document Preparation
Sep. 27, 1993 (Mon.)	09:00	Courtesy Call to JICA Thailand Office
	10:00	Courtesy Call to Embassy of Japan
	14:00	Courtesy Call to Department of Technical and Economic Cooperation (Mr. Nipon Sirivat, Chief of Japan Sub-Division, DTEC, Tel: 281-2747)
	15:30	Courtesy Call on Mr. Sathien Vongvichien, Director-General of Harbour Department Tel: 233-5087
Sep. 28, 1993 (Tue.)	10:00-	Courtesy Call to Port Authority of Thailand and Exchange Views with its ex-participants (Mr. Soontorn Nimskont will wait for the Team at OB Bldg., PAT Tel: 249-0399 ext. 2471)
	11:00-	Observation on Port of Bangkok
	14:00-	Preparation for the seminar
Sep. 29, 1993 (Wed.)	09:00-16:00	Open Technical Seminar in the field of Port and Harbour Engineering at the Imperial Hotel (Ruamrudee Room)
Sep. 30, 1993 (Thu.)	09:00-12:00	Second day for the Seminar
Oct. 1, 1993 (Fri.)	22:10	Mission leaves for Japan by JL 718

V. SEMINAR AGENDA

Seminar Schedule

Title: Seminar on Ports and Harbours Engineering in Japan

Place: The Imperial Hotel (Ruamrudee Room), Wireless Road

September 29, 1993 (Wed.)

09:00-09:30	Registration
09:30-10:00	Opening Ceremony - Opening address by Dr. Tsutomu FUKUTE, Team Leader - Address by Mr. Yasuhisa NAKAJIMA, Assistant Resident Representative of JICA Thailand Office - Address by Cdr. Karn Tantivejakul RTN, Assistant Director of the Bangkok Port
10:00-10:30	Outline of JICA Activities by Ms. Kiyoko KANI, JICA
10:30-10:40	Coffee Break
10:40-11:30	Lecture by Mr. Yasunori MAKITA, MOT - Japanese International Cooperation Policy in the Field of Port and Harbours - Recent Technological Trend on Ports and Harbours Engineering in Japan
11:30-13:00	Luncheon hosted by the Team Leader (Lumpinee Room)
13:00-14:10	Lecture by Dr. Tsutomu FUKUTE, PHRI - Overage of Port Facilities
14:10-14:30	Coffee Break
14:30-15:30	Lecture by Mr. Keita FURUKAWA, PHRI - Environmental Preservation and Coastal Development"
15:30-16:00	Discussion

September 30, 1993 (Thu.)

09:00-10:00	Report by Cdr. Karn Tantivejakul RTN, Assistant Director of the Bangkok Port on "PRESENT SITUATION AND PORT DEVELOPMENT STRATEGY IN THAILAND"
10:00-10:30	Discussion
10:30-11:00	Closing Ceremony
11:00-12:30	Luncheon hosted by the Team Leader (Jimmy Kitchen Room)

VI. PERSONNEL IN THAILAND WHOM THE TEAM MET

(1) DTEC (DEPARTMENT OF TECHNICAL AND ECONOMIC COOPERATION)

MR. NIPON SIRIVAT, CHIEF OF JAPAN SUB-DIVISION, EXTERNAL COOPERATION DIV. 1

MRS. PENSRI CHAICHALERMWONG, PROGRAMME OFFICER

(FOR CHIEF OF TRAINING ANALYSIS SUB-DIV. DIV. OF POLICY AND PLANNING)

MISS SIRIWAN KARNSIRIKUL, PROGRAMME OFFICER (JAPAN SUB-DIVISION)

(2) HARBOUR DEPARTMENT, MINISTRY OF TRANSPORT

MR. VICHET ROJANADHAMKUL, DEPUTY DIRECTOR GENERAL,

(3) PORT AUTHORITY OF THAILAND

MR. VICE ADMIRAL SOMNUK DEBAVAL, DIRECTOR GENERAL

MRS. MEDHINEE THAMARUNGSRI, DEPUTY DIRECTOR OF ENGINEERING DEPARTMENT

MR. SURAJIT PETYIM, DEPUTY DIRECTOR OF PROJECT AND PLANNING DEPARTMENT

MR. CHALERMCHAI MEEKUN-IAM, DIRECTOR OF PLANNING DIVISION

MR. SOONTORN NIMSKONT, DIRECTOR OF CARGO OPERATION 3 DIVISION

MRS. ATCHARA SUTHANYAPRUK, DERECTOR OF PUBLIC RELATION DIVISION

MR. PITAK SILPRASIT, CHIEF OF CONTAINER YARD CONTROL SECTION

VII. SUMMARY OF THE FINDINGS AND IMPRESSION OF THE TEAM

1. DTEC (DEPARTMENT OF TECHNICAL AND ECONOMIC COOPERATION)

Findings in the interview with the staff members of Japan Sub-Division, DTEC, are summarized as several points mentioned below.

(1) The group training course in Port and Harbour Engineering II is very useful to Thailand.

(2) Before sending applicants to Japan, DTEC goes on an English examination and candidate whose points are under 70% cannot be nominated by DTEC. In case participants concerned with projects and who achieved 50-70% will be nominated only after they take the English Class which is held for 10 weeks by the DTEC. We understood the reason why participants from Thailand can speak English very well.

(3) Concerning to the G.I., DTEC decides where to send.

(4) Concerning to the Alumni Association for this course, there is little possibility to organize them under DTEC's conduction.

(5) Concerning to the Naval problem, we answered that we cannot accept any participants form Naval Organization so far, under our ODA principles.

(6) They send participants to America, EEC, Germany, Australia as well as Japan.

(7) Lastly, they requested us to accept some more participants to this training course.

2. HARBOUR DEPARTMENT, MINISTRY OF TRANSPORT AND COMMUNICATION

This is the organization whose main function is to go on the examination and give permission to Port Authority, other relevant governmental organizations concerned to the ports, and private companies in terms of their planning, designing, executing of the ports, pilot services, customs and environmental activities, and so on. However, they haven't sent any participants for the course. Therefore they would like to participate in the training course, if possible, in order to get the necessary knowledge for going on their activities mentioned above.

3. PAT (PORT AUTHORITY OF THAILAND)

PAT is the organization that has sent most of the participants from Thailand to participate in this training course. We talked with 5 ex-participants, and we were surprised that they remembered the training and life in Japan so clearly, in spite that they had come to Japan about 15 years ago.

According to their explanation, the most significant topic is the improvement of container terminal operation and management, especially, computerization. They also requested to make another high-grade training course for ex-participants. But they were satisfied when we explained that there were group training course in Port Administration and Management, and Development of Container Terminal.

In terms of the training course, they asked us if there are any course concerned with the environmental issue. We introduced that we have one lecture in the group training course in Port and Harbour Engineering II, and also we have some other courses which handles the environmental issue from the general point of view. They pointed out that this topic is very important since they must implement the environmental impact assessment (EIA). Environmental pollution in this area consists of eutrophication, oil pollution, but so far they don't recognize the pollution caused by the heavy metals.

They requested to increase the number of participants to attend the course from Thailand, and also suggest us to send some of them with their own budget.

Lastly, we had a chance to look around the Klontoey Port facilities. Subsidence of the Container Yard is terrible, some of the place it got to about 15 cm. Concrete piles of the pier corroded heavily. It seems that their facilities must be implemented maintenance totally in the near future. The pollution of the river nearby the port is heavily, too.

4. OPEN TECHNICAL SEMINAR

(1) We had the open technical seminar on Sept. 29 and 30. Throughout these two days, about 80 persons attended to the seminar in total. They were participated very eagerly. Concerning to the seminar agenda, please refer to "V. Seminar Agenda."

(2) On the second day of the seminar, Cdr. Karn Tantivejakul RTN, Assistant Director of the Bangkok Port had a presentation on "Present Situation and Port Development Strategy in Thailand." The points of his presentation are as follows;

1) present problems of the Bangkok Port:

-Since it is a river port, they must operate the port within a limited capacity.

-Bangkok's traffic jam.

2) present problems of the Leam Chabang Port

-Lack of access routes to Bangkok in reasonable costs.

-Environmental pollution caused by the coal.

3) development strategy of the Bangkok Port

-Office automarization.

-Rearragement of the facilities.

-Renewal of the facilities.

-Privertization.

-Countermeasure to the envieonmental pollution.

4) development strategy of the Leam Chabang Port

-To solve the transportation problem from Leam Chabang to Bangkok.

-To arrange the infra-structure.

(3) On the second day of the seminar, after Cdr. Karn's presentation, we had a discussion on the port development strategy. Points of the discussion are as follows.

1) Everyone agreeded the necessity and significance of the port development for the developmsnt of Thailand.

2) The present port development plan lacks the viewpoint of nationwide strategy, especially, at present, too many ships are concentrated to the Bangkok Port, rather than the others.

3) The problem of lack of the numbers of qualified pilots must be solved. The pilots authorized by the government are very little right now, while under the present regulation, each port cannot train its own pilots. It is significant because it has the close relationship with keeping the ports safety. They also requested us to organize the training course in pilotage, and we advised to take the official route.

(4) At the end of the seminar we asked attendants of the seminar if there were any comments to the training and follow up activities. Three suggestion were collected.

1) To dispatch this kind of follow up team more often in order to brush up the knowledge.

2) To hold this kind of seminar for 1 or 2 weeks in Thailand.

3) To change the training course's qualification, and make the participants from the private sectors can also join in the training course.

5. CONCLUSION

Concerning to the discussion, the topics on the managemental and operational issues are highly spotlighted and those on the hardware such as designing, executing and maintenance of the port facilities are only a little.

As a whole we have an impression that the group training course in Port and Harbour Engineering II is very useful in Thailand. In PAT, ex-participants have achieved in a certain level in position, and contribute to the organization. It seems that it is of much more importance that the ex-participants should hand down the knowledge and information acquired in Japan, and we should put more stress on the topics concerned with the computerization and environmental issues in the training programme.

JICA