CONCRETE LIBRARY OF JSCE NO. 14, MARCH 1990

STANDARD SPECIFICATION FOR DESIGN AND CONSTRUCTION OF CONCRETE STRUCTURES —1986, PART 2 (Construction)

(CONCRETE LIBRARY SPECIAL PUBLICATION 1)

Prepared by JSCE Committee on

STANDARD SPECIFICATION FOR DESIGN AND

CONSTRUCTION OF CONCRETE STRUCTURES

Japan Society of Civil Engineers

YOTSUYA 1-CHOME, SHINJUKU-KU

TOKYO, 160 JAPAN

CONCRETE LIBRARY OF NO. JSCE 14. DECEMBER 1989

STANDARD SPECIFICATION FOR DESIGN AND CONSTRUCTION OF CONCRETE STRUCTURES—1986, Part 2 (Construction)

(Excerpt from Special Publication of JSCE, C.L. SP-2)

JSCE Concrete Committee on Standard Specification for Design and Construction of Concrete Structures

Yoshiro HIGUCHI, Chairman

Yukio AOYAGI	Taisuke AKIMOTO	Shoji IKEDA
Shunji INOMATA	Noriaki IWASAKI	Tadayuki OHARA
Tsunehiro OHUCHI	Toshitaka OHTA	Yoshio OZAKA
Kiyoshi OKADA	Hajime OKUMURA	Hideyuki KETO
Juro KODERA	Kazusuke KOBAYASHI	Shigetoshi KOBAYASHI
Masaki KOBAYASHI	Wataru KOYANAGI	Yukimasa GOTO
Kiyoshi KOHNO	Michiyuki KOHNO	Masatane KOKUBU
Takeshi SAKAI	Seishi JOJIMA	Eiichi TAZAWA
Koichi TAMURA	Kazuo TSUNO	Takashi TODA
Yoshiharu TOKUMITSU	Norio NAKAYAMA	Shigeyoshi NAGATAKI
Noriaki NISHIZAWA	Isao NOGUCHI	Yoichi NOJIRI
Yoshio FUJITA	Atsuhiko MACHIDA	Mitsuharu MIKOSHIBA
Jiro MURATA	Masaki YACHIDA	Tsutomu YANAGIDA
Jun YAMAZAKI	Yukio YOKOMIZO	Hirotomo YOSHIDA
Akira WATANABE	Takeshi WATANABE	

Chairmen of twenty three working groups and subjects.

1	Yoshiro HIGUCHI	General
2	Shigeyoshi NAGATAKI	Cement, Admixture
3	Masaki KOBAYASHI	Aggregate
4	Akira WATANABE	Mixproportion, Quality
5	Yoichi NOJIRI	Temperature
6	Toshitaka OHTA	Durability
7	Noriaki IWASAKI	Under water concrete, Prepacked concrete
8	Hirotomo YOSHIDA	Batching, Mixing
9	Eiichi TAZAWA	Transportation, Placing
10	Kazusuke KOBAYASHI	Spacing
11	Kiyoshi KOHNO	Manufacturing product
12	Tsunehiro OHUCHI	Lightweight concrete
13	Mitsuharu MIKOSHIBA	Design General
14	Mitsuharu MIKOSHIBA	General, Design principle, Load, Structural analysis
15	Hajime OKAMURA	Ultimate capacity-Flexure, Shear, Torsion
16	Masaki YACHIDA	Crack, Fatigue, Deflection, Durability
17	Wataru KOYANAGI	Material-Concrete, Steel
18	Shoji IKEDA	Seismic design
19	Tsunehiro OHUCHI	Prestressed Concrete
20	Yukio YOKOMIZO	Design of members

21 Yoshio OZAKA — Steel Reinforced Concrete
22 Shigetoshi KOBAYASHI — Pavement
23 Seishi JOJIMA — Dam

Subcommittee on English Edition of the STANDARD SPECIFICATION

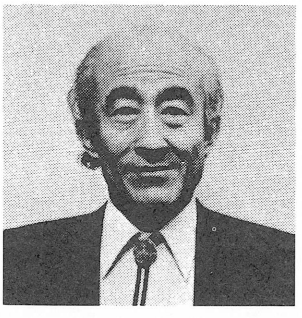
Hajime OKAMURA, Chairman
Jun YAMAZAKI, Secretary

Yoshio YOKOYAMA	Yoshiaki NEGAMI	Takafumi NAITO
Yoichi NOJIRI	Yasuhiko YAMAMOTO	Tamon UEDA
Isao AIHARA	Takayuki ISHIZUKA	Taketo UOMOTO
Kikuo KOSEKI	Yasunori YAMAGUCHI	

Working Group for PART 2 (Construction)

Yasuhiko YAMAMOTO, Chairman

Yukikazu TSUJI	Taketo UOMOTO	Toshiaki MIYAGAWA
Hidetaka UMEHARA	Hirotaka KAWANO	Nobuyuki MATSUMOTO
Kikuo KOSEKI	Yasunori MATSUOKA	Akemichi HAMAJIMA
Toshio YONEZAWA	Hiramasa AOKAGE	Akira UCHIDA
Takeyuki KAYA	Kenji NOMOTO	Yasunori YAMAGUCHI
Masahiro SHIGEI	Masao YAMAMOTO	Hiromi FUJIWARA
Fumiyoshi OHNO	Hiromichi YOSHIKAWA	

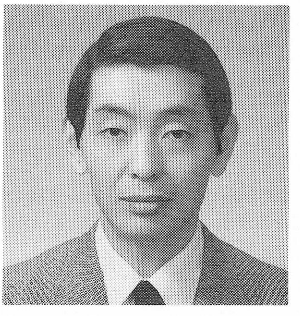


Yoshiro HIGUCHI

Chairman of Committee on Standard Specification and Chairman of JSCE Concrete Committee 1982-1986

Hajime OKAMURA

Chairman of Committee on English Edition



Jun YAMAZAKI

Secretary

Introduction

The Standard Specification for Design and Construction of Concrete Structures written by Japan Society of Civil Engineers forms a base line of the state of the practice of the public works construction in Japan. The document consists of Part 1 Design, Part 2 Construction, Part 3 Pavement, Part 4 Dam, and Part 5 JSCE Standards.

A major revision was made for the 1986 edition to incorporate recent developments in structural and construction technologies and, for the first time, to adopt a limit state design method.

The JSCE Subcommittee on standard specification for design and construction of concrete structures was chaired by Dr. Yoshiro Higuchi. Twenty three working Groups respectively prepared chapters dealing with :

general ; cement ; admixture ; aggregate ; proportion, quality ; temperature ; durability ; under water concrete, prepacked concrete ; batching, mixing ; transporting, placing ; spacing ; manufacturing product ; lightweight concrete ; design general ; general, design principle, load, structural analysis ; ultimate capacity, flexure, shear, torsion ; crack, fatigue, deflection, durability ; materials, concrete, steel ; seismic design ; prestressed concrete ; design of members ; steel reinforced concrete ; pavement ; and dam.

Each chapter consists of the main text and comments.

English translation was made for Part 1 Design and for Part 2 Construction by a committee chaired by Dr. Hajime Okamura . The English translation covers the subject areas listed above except Part 3 Pavement and Part 4 Dam. The English translation are in two volumes and are titled ;

"Standard Specification for Design and Construction of Concrete Structures 1986, Part 1 (Design), First Edition",

Concrete Library International Special Publication, C.L .I. Sp-1, Japan Society of Civil Engineers, 244 p.

"Standard Specification for Design and Construction of Concrete Structures 1986, Part 2 (Construction), First Edition",

Concrete Library International Special Publication, C.L.I. SP-2, Japan Society of Civil Engineers, 306 p.

They can be ordered for purchase to Japan Society of Civil Engineers.

The chapters contained in the Part 2 Construction are as follows.
STANDARD SPECIFIATION FOR DESIGN AND CONSTRUCTION OF CONCRETE STRUCTURES 1986 PART 2(Construction)

CONTENTS

On the following pages appear the excerpts from the Part 2 Construction. They are;
Preface to the original Japanese edition,
Preface to English Edition,
Selected articles with their comments included for some of them.
In selecting the articles, an effort was made to eliminate those articles which are common to other specifications. However, some of fundamental ones are also included.

Preface to the original Japanese edition of the "Standard Specification for design and construction of concrete structures 1986".

PREFACE

The Standard Specifications for Design and Construction of Concrete Structures have been established by the Concrete Committee of the Japan Society of Civil Engineers (JSCE).

The Concrete Committee was formed in 1930 as the Board of Concrete Investigation (Chairman, Dr. Muneharu OHKAWATO). The chairmanship had since then been succeeded by Dr. Tokujiro YOSHIDA (1948-1960) and Dr. Masatane KOKUBU (1960-1982) before the present committee was organized in 1982.

The previous revision of Standard Specifications was made in 1974 and further amendment in 1980. The followings are main backgrounds for publishing the 1986 Edition incorporating many basic revisions.

1. Almost all necessary preparation was completed for introducing the limit state design method.
2. Recent technical development and improvement in the fields of material and construction methods were remarkable.
3. Social demands for environmental preservation, saving of energy and natural resources, etc. became stronger than ever. In particular, serious questions were raised concerning the durability of concrete structures constructed during the high growth period of the Japanese economy.

One of the distinguishing features of the present Standard Specifications is that many basic revisions were made taking into account of the above-mentioned backgrounds. However, in order to avoid confusions which may result from the abrupt revisions, such consideration as to provisionally accept the allowable stress design method in the former standard Specifications was made. Another feature is that "Maintenance and Control of Structures (Draft)" is compiled as an appendix, based on the judgement that the maintenance and the repair of concrete structures will be important issues in the future. Considering that basic provisions have been revised, and that concrete technology is progressing day by day, it is obviously necessary to make further efforts to make the contents of the Standard Specifications more appropriate. The Concrete Committee intends to continue investigations and researches for the improvement of the Specifications.

Completion of the Standard Specifications and their comments with many basic revisions was possible due to the efforts of the committee members, especially the chairmen and the secretaries of the subcommittee and the working groups, who exerted their utmost efforts. I would like to express my profound gratitude to them.

October, 1986

Yoshiro HIGUCHI, Chairman
Concrete Committee
The Japan Society of Civil Engineers

CHAPTER 1 GENERAL

1.2 General Requirements

(2) As a rule, when constructing concrete structures, there shall be engineers at the construction site who have sufficient knowledge about concrete construction.

[Comments]

(2) The term "engineers" mentioned in paragraph (2) corresponds to Concrete Engineers authorized by JCI, Chief Concrete Engineers authorized by JCI, and engineers of sufficient technical abilities equal or superior to them.

CHAPTER 2 QUALITY OF CONCRETE

2.2 Strength

(1) In general, the strength of concrete shall be expressed by the strength tested at the age of 28 days.

2.3 Limit of Chloride Content in Concrete

The allowable maximum limit of chloride content in a concrete mix at the time of mixing shall be properly set considering the type, importance, environmental conditions and other related factors of the structures.

[Comment]

When the allowable limits for chloride content in concrete can not be specified, the following limits may be used as standard.

(1) The total chloride content in ordinary reinforced concrete and prestressed concrete with post-tensioning system shall not exceed 0.60 kg/m^3.

(2) For both reinforced concrete, to which especially high durability is required, and prestressed concrete with post-tensioning system that are subjected to the attacks of chloride and electrolytic corrosion, and for prestressed concrete with pre-tensioning system, the allowable limit shall be 0.30 kg/m^3.

CHAPTER 3 MATERIALS

3.2 Cements

(1) Ordinary, high-early-strength, ultra-high-early-strength, moderate-heat and sulfate-resisting portland cements shall conform to the requirements of JIS R 5210 "Portland Cement". Portland blast-furnace slag, portland pozzolan and portland fly ash cements shall conform to the requirements of JIS R 5211 "Portland Blast-Furnace Slag

Cement", JIS R 5212 "Portland Pozzolan Cement" and JIS R 5213 "Portland Fly Ash Cement" respectively.

[Comments]

(1) There are 10 types of portland cement specified in JIS; ordinary, high-early-strength, ultra-high-early-strength, moderate-heat, sulfate-resisting cements, and their low-alkali types (total percentage of alkali content is not larger than 0.6 %).

3.3 Mixing water

Mixing water shall not contain an injurious amount of impurities such as oil, acid, salts, organic impurities, suspended solids and so on which adversely affect the quality of concrete and steel.

3.4 Fine Aggregates

3.4.2 Grading

(1) Fine aggregates shall be properly graded, with a mixture of aggregates of various sizes as shown in Table 3.4.1 below as standard. Sieve analysis of fine aggregates shall be done in accordance with JIS A 1102.

Table 3.4.1 Standard grading of fine aggregates

Nominal size (Sieves with square openings) (mm)	Weight percent passing through (%)	Nominal size (Sieves with square openings) (mm)	Weight percent passing through (%)
10	100~	0.6	25~65
5	90~100	0.3	10~35
2.5	80~100	0.15	2~10 A)
1.2	50~ 90		

Note: A) When only crushed sand or blast-furnace slag fine aggregate is used as fine aggregate, this range may be 2~15%.

3.4.3 Limit of deleterious substances

(1) Content of deleterious substances in fine aggregates shall not exceed the limits prescribed in Table 3.4.2.

Table 3.4.2 Limits of content for deleterious substances in fine aggregates (weight percent)

Item	Maximum limit
Clay lumps	1.0[A]
Loss in washing test	
Concrete subject to abrasion	3.0[B]
All other concrete	5.0[B]
Coal and lignite whose gravity is lighter than that of heavy liquid (specific gravity=1.95)	
Where surface appearance of concrete is of importance	0.5[C]
All other concrete	1.0[C]

Note : A) Test samples are the residual materials retained on the sieve after the washing test of fine aggregates is made in accordance with JIS A 1103.

B) In the case of crushed sand or blast-furnace slag fine aggregate, if the washed-out materials consist of dust from fracturing, and are essentially free from clay or shale, these limits may be increased to 5.0 and 7.0%, respectively.

C) These requirements are not applicable to blast-furnace slag fine aggregates.

(2) Organic impurities

(a) Organic impurities contained in fine aggregate shall be tested in accordance with JIS A 1105. In this case, the color of the liquid at the upper part of the sand shall be lighter than the standard color.

(b) Even if the color of the liquid at the upper part of the sand is darker than the standard color, the sand can be used if the compressive strength of the mortar made using the sand is not less than 90 % of that of mortar which is prepared using the sand from the same source but washed with a 3 % solution of NaOH and, then, rinsed thoroughly with fresh water.

3.4.4 Durability

(2) Fine aggregate shall have a loss of not larger than 10 % by weight, when subjected to 5 cycles of the procedures prescribed in the soundness test using sodium sulfate.

(6) Chemically or physically unsound fine aggregate shall not be used. However, this kind of fine aggregate may be accepted, provided that the aggregate is judged or confirmed not to cause harmful effects by its past performance record, the conditions of its use, and the results of its chemical and/or physical soundness tests.

[Comments]

(6) Usually, soundness for the alkali-aggregate reaction is tested at first by the

method specified in either ASTM C 289 "Method of Test for Potential Reactivity of Aggregate (Chemical Method)" or Appendix 7 of JIS A 5308 "Method of Test for Reactivity of Aggregate for Alkali-Silica Reaction (Chemical Method)" or by a modified method of these two methods. Then, aggregates judged to be "Reactive" or "Potentially Reactive" is further tested using ASTM C 227 "Method of Test for Potential Reactivity of Cement-Aggregate Combinations (Mortar Bar Method)", Appendix 8 of JIS A 5308 "Method of Test for Reactivity of Aggregate for Alkali-Silica Reaction (Mortar Bar Method)" or a modified method of these methods. If the expansion of mortar at the age of 6 months is greater than 0.10 % (or 0.05 % at 3 months), the aggregate is generally judged to be reactive.

3.4.5. Sea sand

(1) The limits of chloride content in sea sand shall be set properly considering the types and importance of structures, environmental conditions and so on.

[Comments]

(1) Standard limits for a chloride content in sea sand may be specified as follows.

In cases of general reinforced concrete and prestressed concrete with a post-tensioning system, whose standard allowable limit for chloride ion content in concrete is not more than 0.6 kg/m^3, the standard limits for the content of chloride ion in fine aggregate in an oven-dry state shall not be larger than 0.06 % (0.1 %NaCl as calculated) by weight. And when the allowable unit chloride ion content in concrete is not more than 0.30 kg/m^3, the standard limits of chloride ion in fine aggregate in an oven-dry state shall not be larger than 0.02 % (0.03 %NaCl as calculated).

3.5 Coarse Aggregates

3.5.2 Grading

Coarse aggregate shall be properly graded, with a mixture of aggregate of various sizes as shown in Table 3.5.1 below as standard.

Table 3.5.1 Standard grading of coarse aggregate

Size of coarse aggregate (mm)	Amounts finer than each laboratory sieve (weight percent) Nominal size (Sieves with square openings)											
	100	80	60	50	40	30	25	20	15	10	5	2.5
50~5	–	–	100	95~100	–	–	35~70	–	10~35	–	0~5	–
40~5	–	–	–	100	95~100	–	–	35~70	–	10~30	0~5	–
30~5	–	–	–	–	100	95~100	–	40~75	–	10~35	0~10	0~5
25~5	–	–	–	–	–	100	95~100	–	30~70	–	0~10	0~5
20~5	–	–	–	–	–	–	100	90~100	–	20~55	0~10	0~5
15~5	–	–	–	–	–	–	–	100	90~100	40~70	0~15	0~5
10~5	–	–	–	–	–	–	–	–	100	85~100	0~40	0~10
80~40[A)]	100	90~100	45~70	–	0~15	–	–	0~5	–	–	–	–
60~40[A)]	–	100	90~100	35~70	0~15	–	–	0~5	–	–	–	–
50~25[A)]	–	–	100	90~100	35~70	–	0~15	–	0~5	–	–	–
40~20[A)]	–	–	–	100	90~100	–	20~55	0~15	–	0~5	–	–
30~15[A)]	–	–	–	–	100	90~100	–	20~55	0~15	0~10	–	–

Note : A) These are for coarse aggregates to be stored and weighed separately and mixed with other coarse aggregates of different sizes in order to minimize the variation of total grading.

3.5.3 Limit of deleterious substances

The content of deleterious substances shall not be more than the limits prescribed in Table 3.5.2.

Table 3.5.2 Limits of content for deleterious substances in coarse aggregate (weight percent)

Item	Maximum limit
Clay lumps	0.25[A)]
Loss in washing test	1.0[B)]
Coal and lignite whose gravity is lighter than that of heavy liquid (specific gravity=1.98)	
Where surface appearance of concrete is of importance	0.5[C)]
All other concrete	1.0[C)]

Note : A) Test samples are the residual materials retained on the sieve after the washing test of coarse aggregate is made in accordance with JIS A 1103.

B) In the case of crushed stone, if washed-out materials consist of dust from fracturing, the limit may be increased to 1.5%. In the case of blast-furnace slag coarse aggregate, it may be increased to 5.0%.

C) These requirements are not applicable to blast-furnace slag coarse aggregates.

3.5.4 Durability

(2) Coarse aggregate shall have an average loss of not larger than 12 % by weight

when subjected to 5 cycles of the procedures prescribed in the soundness test using sodium sulfate.

(6) Chemically or physically unsound coarse aggregates shall not be used. However, this kind of coarse aggregate may be accepted, provided that the aggregate is judged or confirmed not to cause harmful effects by its past performance record, the condition of its use, and the results of its chemical and/or physical soundness test.

3.5.5 Crushed stone

Crushed stone shall conform to the requirements of JIS A 5005.

[Comment]

JIS A 5005 "Crushed Stone for Concrete" prescribes a method of test for solid volume percentage of bulk aggregate in order to judge the suitability of the aggregate by particle shape, and specifies that the value shall be not less than 55 % for crushed stone aggregate whose maximum size is 20 mm.

3.6 Admixtures

3.6.2 Mineral admixtures

(1) Fly ash to be used as a mineral admixture shall conform to the requirements of JIS A 6201.

(2) Expansive admixtures to be used as mineral admixtures shall conform to the requirements of JIS A 6202.

(3) Ground granulated blast-furnace slag to be used as mineral admixtures shall conform to the requirements of the JSCE Standard "Ground Granulated Blast-Furnace Slag for Concrete".

(4) For mineral admixtures other than (1), (2) and (3), it is necessary to test their quality and study the proper methods of use thoroughly.

3.6.3 Chemical admixtures

(1) Air-entraining agents, water-reducing agents and air-entraining and water-reducing agents to be used as chemical admixtures shall conform to the requirements of JIS A 6204.

(2) Superplasticizers to be used as chemical admixtures shall conform to the requirements of the JSCE Standard "Superplasticizers for Concrete".

(3) Corrosion inhibitors for reinforcing steel to be used as chemical admixtures shall conform to the requirements of JIS A 6205.

(4) For chemical admixtures other than (1), (2) and (3) above, it is necessary to test their quality and study the proper methods of use thoroughly.

3.7 Reinforcing bars

(1) Reinforcing bars shall basically conform to the requirements of JIS G 3112.

(2) Reinforcing bars which conform to the requirements of JIS G 3117 shall be

tested before use.

(3) When reinforcing bars not conforming to the requirements of JIS G 3112 and JIS G 3117 are to be used, they shall be tested and then their design strength and application method shall be decided.

(4) Galvanized reinforcing bars shall conform to Provision 5 of the JSCE Recommendation "Recommendations for Design and Construction of Reinforced Concrete Structures Using Galvanized Reinforcing Steel Bars".

(5) Epoxy-coated reinforcing bars shall conform to the requirements of the JSCE Standard "Epoxy-Coated Reinforcing Steel Bars".

CHAPTER 4 MIX PROPORTIONS

4.2 Mix Proportioning Strength

(2) In general, the mix proportioning strength shall be determined in such a manner that the probability of values of on-site compressive strength tests falling below the characteristic compressive strength of concrete (f'_{ck}) is less than 5 %.

4.3 Water-Cement Ratio

The water-cement ratio shall be determined based on the required strength and durability of concrete. For structures to be water-tight, the water-tightness of concrete shall be also considered.

(1) In the case of determining the water-cement ratio based on compressive strength, the following method shall be employed.

(a) The relationship between compressive strength and cement-water ratio shall be determined by tests in principle. Twenty-eight days shall be regarded as a standard test age.

(b) The water-cement ratio to be used for the determination of mix proportions shall be a reciprocal number of the cement-water ratio, which is obtained as a corresponding value to the mix proportioning strength (f'_{cr}) on the relationship line between cement-water ratio (C/W) and compressive strength (f'_c) at the designated age. This f'_{cr} shall be a value which is obtained by multiplying the characteristic compressive strength of concrete (f'_{ck}) by a proper overdesign factor. It is noted that this factor shall be so determined that the probability of values of strength tests falling below the characteristic compressive strength of concrete shall not exceed 5 %, according to the coefficient of the variation of compressive strength expected at each construction site. The factor shall be obtained from the curve shown in Figure 4. 3. 1.

(2) In the case of determining the water-cement ratio based on the freeze-thaw resistance of concrete, the water-cement ratio shall not exceed those shown in Table 4. 3. 1.

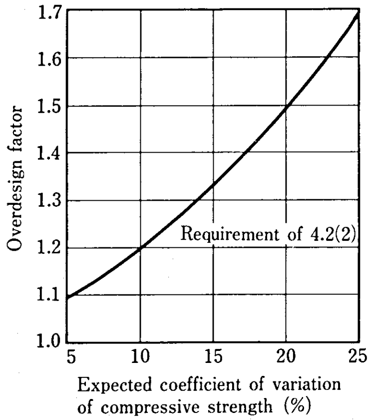


Fig. 4. 3. 1 Overdesign factor for general use

Table 4. 3. 1 Maximum water-cement ratio of air-entrained concrete when freeze-thaw resistance is to be considered (%)

Exposure condition of structure	Severe weathering or frequent cycles of freezing and thawing		Moderate weathering or infrequent freezing	
	Cross section			
	Thin 2)	Ordinary	Thin 2)	Ordinary
(1) Portions continuously or frequently saturated with water 1)	55	60	55	65
(2) Portions exposed to ordinary conditions other than (1)	60	65	60	70

1) Waterways, water tanks, bridge abutments, bridge piers, retaining walls, tunnel linings etc., which are frequently saturated with water.
Also such portions of structures as girders and deck slabs which are located at a distance from water surface but can be often saturated with water due to melting of snow, water flow, water splash, etc..

2) Portions of structure whose cross sectional thickness is not more than about 20 cm.

(3) In the case of determining the water-cement ratio based on durability against chemical attacks on concrete, the following method shall be employed.

(a) For concrete in contact with soil or water containing 0. 2 % or more sulphate, the water-cement ratio shall not exceed those shown in (a) of Table 20. 3. 1.

(b) For concrete where a deicing agent is expected to be used, the water-cement ratio shall not exceed those shown in (b) of Table 20. 3. 1.

(4) In the case of determining the water-cement ratio based on water-tightness, the water-cement ratio shall be decided in accordance with the requirements in 18. 2. The water-cement ratio for reinforced concrete in marine environment shall be determined in conformity with the requirements in 20. 3. 1.

4. 6 Maximum Size of Coarse Aggregate

The maximum size of coarse aggregate shall not be more than one-fifth of the minimum thickness of members nor three-fourths of the minimum horizontal clearance between reinforcing bars. The general standard of maximum size of coarse aggregate is prescribed in Table 4.6.1.

Table 4.6.1 Maximum size of coarse aggregate

Type of structure	Maximum size (mm)
Ordinary R.C.	20 or 25
Thick R.C.	40
Unreinforced Concrete	40 Not larger than 1/4 of the minimum thickness of member

4.7 Slump

The slump of concrete shall be reduced as much as possible within the range suitable for transportation, placement and consolidation.

As a standard, slump during placing shall be 5 to 12 cm in general cases, 3 to 10 cm for large cross sections and 3 to 8 cm for plain concrete.

4.9 Air Content of Air-Entrained Concrete

(1) The air content of air-entrained concrete shall be normally 3 to 6 % of concrete volume, depending on the maximum size of coarse aggregate and other factors.

4.11 Form for Expressing Mix Proportions

(2) In the specified mixes, fine aggregate shall be defined as that entirely passing through a 5mm sieve and coarse aggregate retained as a whole on a 5 mm sieve. Both aggregates shall be in a saturated surface-dry state.

CHAPTER 5 BATCHING AND MIXING

5.1 Batching

5.1.3 Batching of materials

(3) Materials shall be weighed for each batch of concrete. Water and diluted solutions of chemical admixtures may be measured by volume.

(4) Batching errors shall not be greater than the allowances given in Table 5.1.1.

Table 5.1.1 Permissible errors in batching

Material	Permissible error (%)
Water	1
Cement	2
Aggregate	3
Mineral admixture	2
Chemical admixture	3

(5) When a continuous mixer is used, the materials for concrete may be measured by volume. In this case, errors in measurement shall not exceed the allowances given in Table 5.1.1, when the calculation is made after converting the volumetric quantity of each material per an appropriate specified period into its weight.

5.2 Mixing

5.2.2 Mixers

(1) Both batch mixers and continuous mixers shall be tested respectively in accordance with JIS A 1119 and the JSCE Standard "Method of Test for Mixing Efficiency of Continuous Mixers". They shall be confirmed as having the required mixing capacity.

5.2.3 Mixing

(8) When a continuous mixer is employed, the first portion of the discharged concrete shall be discarded.

CHAPTER 6 READY-MIXED CONCRETE

6.1 General

As a rule, in the case of using ready-mixed concrete, ready-mixed concrete conforming to JIS A 5308 shall be used. Even when ready-mixed concrete under other specifications is used, appropriate provisions as in JIS A 5308 shall be applied on matters not designated in other specifications.

6.2 Choice of Concrete Plants

(1) In principle, the supplier's plant of ready-mixed concrete shall be chosen from among the plants which are not only JIS-mark licensed but also operated or controlled by persons who are authorized by JCI as Concrete Engineer or Chief Concrete Engineer, or by other persons of equal or higher knowledge and experience compared with the authorized Engineers by JCI.

6.3 Designation of Quality

The designation of ready-mixed concrete shall be made correctly with regard to the following matters, principally in accordance with the JIS A 5308.

(1) In the case of Standard Goods

1) Standard Goods, categorized in this part, shall correspond to concretes marked with "○" in Tables 1, 2 and 3 of JIS A 5308. The air content of ordinary concrete and lightweight concrete in this category is normally 4.0 and 5.0% respectively. However, in cold districts, it shall be increased to 4.5 and 5.5% respectively.

2) The purchaser shall choose a suitable combination of nominal strength and slump from among the various combinations shown in Tables 1, 2 and 3 of JIS A 5308.

3) Purchaser shall further specify the following items by consulting with the relevant suppliers :

(a) type of cement

(b) type of aggregate

(c) maximum size of coarse aggregate

(d) limit of chloride content

(e) mass of unit concrete volume, in the case of lightweight concrete

Also, if necessary,

(f) maximum or minimum temperature of concrete

(g) method of suppressing alkali-aggregate reaction

(2) In the case of Special Order Goods

1) Special Order Goods, categorized in this part, shall correspond to concrete marked with "○" and/or "●" in Tables 1, 2 and 3 of JIS A 5308.

2) The purchaser shall choose a suitable combination of nominal strength and slump from among the combinations shown in Tables 1, 2 and 3 of JIS A 5308.

3) The purchaser shall also specify the following items by consulting with the relevant suppliers :

(a) type of cement

(b) type of aggregate

(c) maximum size of coarse aggregate

(d) limit of chloride content

(e) age of concrete guaranteeing nominal compressive strength

(f) type of admixture

(g) air content

(h) mass of unit concrete volume, in the case of lightweight concrete

(i) maximum or minimum temperature of concrete

(j) method of suppressing alkali-aggregate reaction

(k) other necessary items, if any

(3) In the case of Separate Order Goods

1) Separate Order Goods, categorized in this part, do not correspond to concretes marked with "○" and "●" in Tables 1, 2 and 3 of JIS A 5308, but they shall be identified as either concretes having specifications other than those in Sections (1) and (2) above or concretes having a different quality standard.

2) The purchaser shall choose a suitable combination of nominal strength and slump and also specify the other requirements for the concrete by consulting with relevant suppliers.

[Comment]

The generally used combinations of nominal strength and slump, which are picked up from the tables of JIS A 5308 as those conforming to this Standard Specification, are indicated in Tables C6.3.1 to C6.3.3.

Table C6.3.1 For ordinary concrete (maixmum size of coarse aggregate : 20 mm or 25 mm

Slump (cm)	Nominal strength												
	135	150	160	180	195	210	225	240	255	270	300	350	400
5	●	●	●	●	●	●	●	●	●	●	○	○	○
8	○	○	○	○	○	○	○	○	○	○	○	○	○
10	●	●	○	●	●	●	●	●	●	●	●	●	●
12	○	○	○	○	○	○	○	○	○	○	○	●	●
15	○	○	○	○	○	○	○	○	○	●	●	●	●
18	○	○	○	○	○	○	○	○	○	●	●	●	●

Table C6.3.2 For ordinary concrete (maximum size of coarse aggregate : 40 mm)

Slump (cm)	Nominal strength										
	135	150	160	180	195	210	225	240	270	300	Modulus of rupture 45
2.5	–	–	–	–	–	–	–	–	–	–	○
5	●	●	○	○	○	○	○	○	○	○	○
6.5	–	–	–	–	–	–	–	–	–	–	○
8	●	●	○	○	○	○	○	○	○	○	–
12	●	●	○	○	○	○	○	○	○	○	–
15	○	○	○	○	○	○	○	○	●	●	–
18	○	○	○	○	○	○	○	○	●	●	–

Table C6.3.3 For lightweight concrete (maximum size of coarse aggregate : 15 mm or 20 mm)

Slump (cm)	Nominal strength										
	135	150	160	180	195	210	225	240	255	270	300
5	●	●	●	○	●	●	●	○	●	○	○
8	●	●	○	○	●	●	●	○	●	○	○
12, 15	●	●	○	○	○	○	○	○	○	○	○

In JIS A 5308, ready-mixed concretes are classified into Standard Goods and Special Order Goods. "Standard Goods" are defined as frequently-used ready-mixed concretes for which suppliers can determine the mix proportions based upon actual experience of quality control and which are indicated by "○" in **Tables C6. 3. 1** to **C6. 3. 3**. However, it shall be noted that the air content of concrete is constant; namely, 4. 0 % (4. 5 % in cold districts) for ordinary concrete with 20, 25 and 40 mm maximum size coarse aggregate, and 5. 0 % (5. 5 % in cold districts) for lightweight concrete with 15 and 20 mm maximum size coarse aggregate. Concretes of other air contents than these are regarded as Special Order Goods.

Nominal strength, a term used in JIS A 5308 to distinguish it from the characteristic compressive strength of concrete in this Standard Specification, is an assured strength under the conditions specified in Section 4 of JIS A 5308.

6. 4 Acceptance of Supplied Concrete

(5) Acceptance inspections of concrete shall be performed in accordance with JIS A 5308. For superplasticized concrete, such inspections shall be performed on its base concrete in accordance with the JSCE Recommendation "Recommended Practice for Superplasticized Concrete".

CHAPTER 7 TRANSPORTATION AND PLACING

7. 2 General Requirements

(1) Concrete shall be transported quickly, placed immediately and compacted fully. The time from the start of mixing to the completion of the placing shall, in principle, not exceed one and a half hours when the outdoor temperature is above 25°C, and two hours when it is 25°C or below.

7. 3 Transport

7. 3. 3 Concrete pump

(1) Concrete pumps shall be used in compliance with the JSCE Recommendation "Recommended Practice for Pumping Concrete".

7. 4 Placement

7. 4. 2 Placing

(8) When the height of the forms is relatively high, measures shall be taken that an inlet be made in the form or an outlet in the vertical chute or pipe be lowered to be close to the placement surface. Such measures are important to prevent the concrete from segregating, as well as to prevent the adhesion and hardening of concrete from the upper reinforcing bars or forms. In this case, the distance from the outlet of the chute, pipe, bucket, hopper and other devices to the placement surface shall be, as a rule, 1.5 m or less.

7.4.3 Compaction

(3) During vibratory compaction, the vibrator shall be inserted into the lower concrete layer about 10 cm.

(5) When re-vibration is given, appropriate time shall be alloted so as to avoid adverse effects to the concrete.

7.4.4 Treatment of settlement cracks

(2) If settlement cracks have occurred, tamping shall be performed without delay to eliminate such cracks.

CHAPTER 8 CURING OF CONCRETE

8.2 Moist Curing

(2) When the concrete is so hardened that jobs can be performed without damaging the surface, the exposed surface of the concrete shall be kept wet by covering it with a moist curing mat, cloth, and other materials or by sprinkling or filling the area with water. When ordinary portland cement or high-early-strength portland cement is used, the standard periods for keeping it wet shall not be less than 5 days and 3 days respectively.

CHAPTER 9 JOINTS

9.3 Construction of Horizontal Construction Joints

(4) When concrete is invertedly cast, materials used, the mix proportion, and construction method shall be selected so that the construction joints will be integrated, after the consideration of concrete settlement.

[Comments]

(4) In the case of the invertedly poured concrete, a construction joint is always located under the existing concrete, and construction joint surfaces are not usually integrated because of bleeding or the settlement of newly placed concrete placed thereunder. In the case of the invertedly poured concrete, methods of construction in Fig. C 9.3.1 are employed to ensure the integration of the construction joint surfaces. As an alternative method other than the one shown, use of expansive admixture to the newly placed concrete is also feasible.

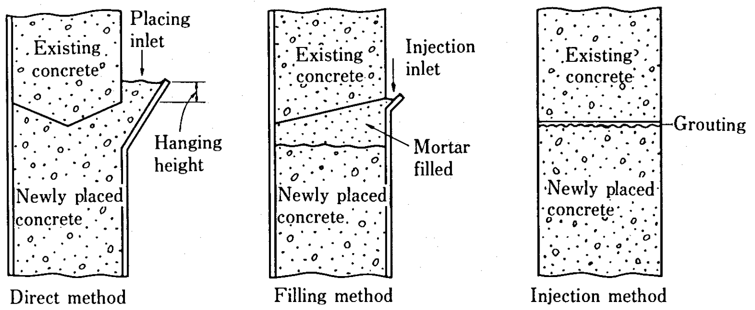


Fig. C 9. 3. 1 Jointing methods in inverted construction

9. 9 Crack-Control Joints

To install a joint in order to control cracks, structure and the positions of joints shall be so determined as not to impair the strength and functions of the structure.

[Comment]

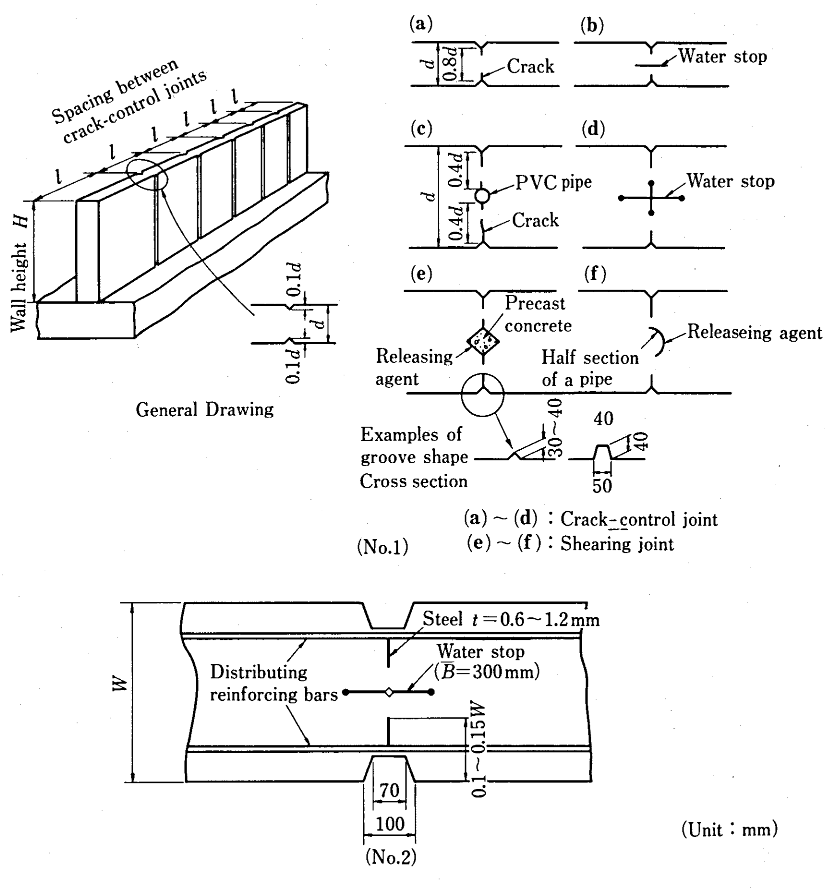


Fig. C 9. 9. 1 Examples of crack-control joints

CHAPTER 10 REINFORCEMENT

10.3 Joint of Reinforcing Bars

(2) A lap joint of reinforcing bars shall have the specified lapping length and be tied at several points with annealed wires of 0.9 mm diameter or larger.

(3) Joints using "Pressed joints", "Thread lugged bar joints", "Threaded joints", "Molten metal infilled joints", "Mortar infilled joints", "Automatically gas pressure welded joints" and "Enclosed arc welded joints" methods shall comply with the JSCE Recommendations "Recommended Rules for Joints in Reinforcing Bars" and "Recommendation for Design and Fabrication of Enclosed Arc Welded Joints in Reinforcing Bars". "Gas pressure welded joint" shall comply with the "Standard Specification for Gas Pressure Welding of Reinforced Bars" published by Japan Pressure Welding Society.

CHAPTER 11 FORMWORK AND SHORING

11.4 Removal of Forms and Shores

11.4.1 Removal of forms and shores

(2) The timing and sequence of form removal shall take into account the characteristics of the cement, the mix proportion of the concrete, importance of the structures, type and dimensions of all members, imposed loads to all members, temperature, weather and ventilation as and so forth.

[Comments]

(2) Table C11.4.1 provides the suggested compressive strengths for the determination of form removal time for RC structures. The strengths are established from past experiences.

Table C11.4.1 Minimum compressive strength for from removal

Portions of members	Example	Compressive strength (kgf/cm²)
• Vertical or almost vertical surfaces of thick members • Upper surfaces of inclined members • Outside surfaces of small arch structures	Sides of footings	35
• Vertical or almost vertical surfaces of thin members • Lower surfaces of members inclined at 45 degrees or more • Inside surfaces of small arch structures	Sides of columns, walls, and beams	50
• Slabs and beams of bridges and buildings • Lower surfaces of members inclined at 45 degrees or less	Bottoms of slabs and beams, Inside surfaces of arch structures	140

CHAPTER 13 QUALITY CONTROL AND INSPECTION

13.3 Quality Control of Concrete

13.3.1 Concrete quality control based on compressive strength

(1) The quality control of concrete based on the compressive strength shall normally be performed using the compressive strength at an early age. In this case, the samples of the concrete specimen shall be taken to represent the concrete quality in the structure.

(2) The average compressive strength of three specimens taken from the same batch shall in general be used as the result of a single compressive strength test for concrete quality control.

(3) The frequency and time for sampling fresh concrete for compressive strength test shall generally be at least once a day or once for each 20-150 m^3 of continuously placed concrete depending upon the importance of the structure and the scale of the work.

13.4 Quality Inspection of Concrete

(2) When inspecting concrete of which the water-cement ratio has been determined on the basis of the compressive strengths, the concrete may be considered to possess the required quality when the probability of the average compressive strength obtained from the tests on cylinder specimens is estimated to fall below 5 % of the characteristic compressive strength with an appropriate percentage of risk. This inspection shall generally be based on the compressive strength at an age of 28 days.

[Comments]

(2) When sampling inspection by variables operating characteristics is employed for quality inspection, the following formula may be adequate to prove satisfactory interrelations using the acceptance coefficient (k) in Fig. C 13. 4. 1

$$\overline{x} \geq f'_{ck} + kS_n$$

where f'_{ck} : characteristic compressive strength of concrete (kgf/cm^2)

$\overline{x}$: mean value of compressive strength of concrete (kgf/cm^2)

$$\overline{x} = \frac{x_1 + x_2 + \cdots\cdots + x_n}{n}$$

S_n : Square-root of unbiased variance (kgf/cm^2)

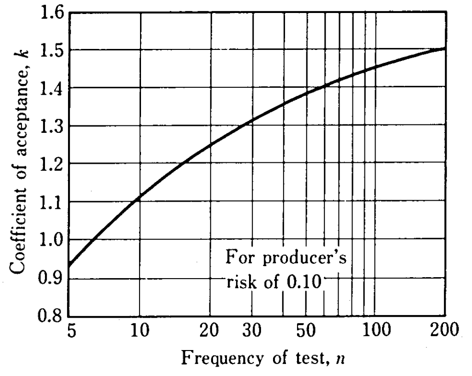


Fig. C 13. 4. 1 Relation between coefficient of acceptance and frequency of test

CHAPTER 14 CONSTRUCTION RECORDS

14. 1 General

The construction program, working conditions, curing method, weather, atmospheric temperature, feature of the tests performed, and other factors shall be recorded during the construction as the circumstances demand. The records of the construction performance shall be preserved over a long period of time.

CHAPTER 15 MASS CONCRETE

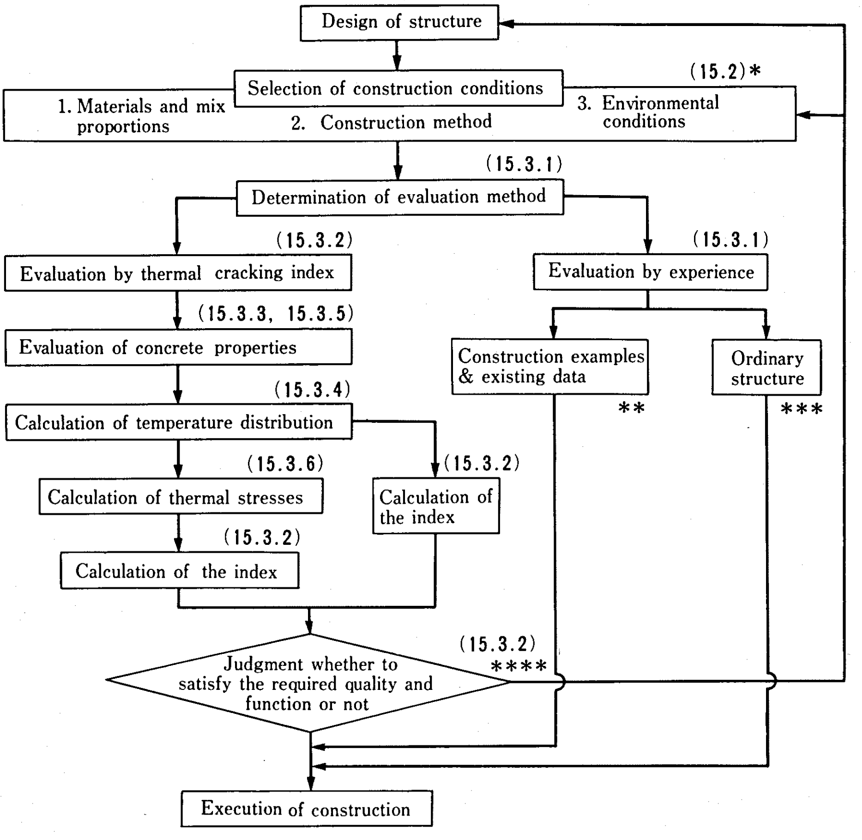
15. 1. 2 General requirements

In mass concreting, a construction plan shall be made after sufficiently examining the thermal stresses and thermal cracking due to the heat of hydration of cement so that the concrete structure can satisfy the quality requirements and the required function. The practice of mass concreting shall comply with the construction plan.

[Comment]

The latest studies have practically established the method to quantitatively understand the influence of these various conditions on crack occurrence and to evaluate their effects on crack control.

In consideration of the said circumstances at present, this chapter introduces the evaluation method in accordance with the flow chart shown in Fig. C 15. 1. 1 as the standard practice, from the viewpoint of crack control in the construction of mass concrete.



* Number in parentheses denotes the corresponding Section.

** Cases for the same type of structures where no trouble has been identified by using the same construction method.

*** Cases in nonsignificant structures to which no such evaluation is known to be necessary from experience.

**** Crack-control joints may be used when it is expected that cracking will occur but the function of the structure will be kept satisfactory by controlling the crack location and by repairing the cracks.

Fig. C 15. 1. 1 Evaluation flow of thermal cracking

15. 3 Evaluation of Thermal Cracking

15. 3. 2 Evaluation by thermal cracking index

(1) In evaluation by the thermal cracking index, the index represented by the following expression is used.

Thermal cracking index$=f_t/\sigma_T$

where f_t : tensile strength of concrete at the age of calculation of σ_T,

σ_T : maximum thermal stress in tension.

(2) The reference thermal cracking index to be used in the evaluation will be determined considering such factors as the importance, the required function and the environmental conditions of the structure.

[Comments]

(2) Concerning the relationship between the occurrence of thermal cracks and the thermal cracking index, the relationship between the probability of cracking and the index has been documented based on several experiments and observation records during actual construction. The reference value of the thermal cracking index needs to be determined referring to such records (Fig. C 15. 3. 1) and considering the importance, function and environmental conditions of the structures. For reference, the standard values of the thermal cracking index are shown as follows:

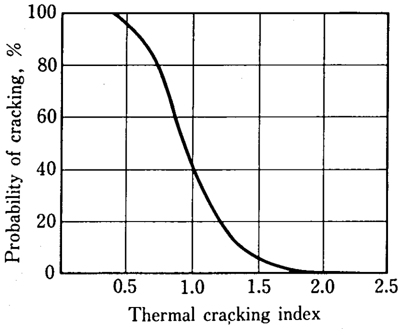


Fig. C 15. 3. 1 Thermal cracking index and probability of cracking

1.5 and above	: when cracking is to be prevented,
1.2-1.4	: when the width and number of cracks are to be controlled while allowing cracking,
0.7-1.1	: when not applicable to the above two.

CHAPTER 16 COLD WEATHER CONCRETING

16.1 General

16.1.1 Scope of application

This chapter provides the general requirements especially needed in cold weather concreting.

When the mean daily temperature is predicted to drop below 4°C, execution of concreting shall be conducted as prescribed in this chapter.

16.5 Transporting and Placing

(2) The placing temperature of concrete shall be determined to be between a range of 5-20°C.

[Comments]

The recommended values of concrete temperature in the general cases are shown in Table C 16. 5. 1.

Table C16.5.1 Recommended concrete temperature in cold weather concreting

Section			Thin	Ordinary	Thick
Minimum concrete temperature at placing (°C)			13	7～10	5
Minimum concrete temperature at mixing (°C)	Ambient air temp.	−1°C and above	16	10～13	7
		−1～−18°C	19	13～16	10
		−18°C and below	21	16～19	13

16.6 Curing

(3) During the curing operations, the temperature of newly-placed concrete shall be maintained at not less than 5°C. Curing control shall be carried out in accordance with Section 16.8.

(6) The curing of concrete exposed to severe weather conditions is continued as a standard practice until the compressive strength shown in Table 16.6.1 is developed. The concrete temperature shall be kept not less than 0°C for two days after the completion of the curing.

Table 16.6.1 Standard values for the required compressive strength of concrete at the end of curing under severe weather conditions (kgf/cm²)

Exposure condition of structure	Thickness of cross section		
	Thin	Ordinary	Thick
(1) Portions continuously or frequently saturated with water	150	120	100
(2) Portions exposed to ordinary conditions other than (1)	50	50	50

[Comments]

(6) The curing period required for the development of the afore-mentioned strength depends on such factors as the type of cement, the mix proportion and the curing temperature, and is determined by testing in principle. Table C16.6.1 shows a rough standard for the curing at 5°C and 10°C.

Table C16.6.1 Standard curing periods for the curing at 5°C and 10°C

Section / Type of cement / Curing temperature / Exposure conditions of structure		Ordinary case		
		Ordinary portland	High-early strength portland, ordinary portland + accelerator	Blended cement Type B
(1) Portions continuously or frequently saturated with water	5°C	9 days	5 days	12 days
	10°C	7 days	4 days	9 days
(2) Portions exposed to ordinary conditions other than (1)	5°C	4 days	3 days	5 days
	10°C	3 days	2 days	4 days

Note : Standard values for $W/C = 0.55$ are shown. Suitable modifications need to be made for different W/C.

CHAPTER 17 HOT WEATHER CONCRETING

17.6 Placing

(2) The period from the mixing to the completion of the placing shall not exceed 1 hour and 30 minutes as a rule.

(3) Concrete temperature at the time of placing shall not be higher than 35°C.

CHAPTER 18 WATERTIGHT CONCRETE

18.2 Water-Cement Ratio

The water-cement ratio shall not exceed 55 %, as a rule.

CHAPTER 19 LIGHTWEIGHT AGGREGATE CONCRETE

19.2 Lightweight Aggregates

(2) Lightweight aggregates must confirm to the following four classifications specified in JIS A 5002.

Fine artificial lightweight aggregate	MA 317.
Fine artificial lightweight aggregate	MA 417.
Coarse artificial lightweight aggregate	MA 317.
Coarse artificial lightweight aggregate	MA 417.

(7) The content of floating particles shall be not more than 10 %. The content of floating particles shall be tested based on JIS A 5308 Appendix-4 "Testing Method of Percentage of Floating Particles".

19.5 Mix Proportions

19.5.2 Water-cement ratio

(2) When the water-cement ratio of the lightweight aggregate concrete using portland cement is determined by freeze-thaw resistance, the ratio shall be 5 % less than the values shown in Table 4. 3. 1.

19.5.3 Slump

(1) The concrete slump shall be minimized within the range of appropriate workability. It shall be 5 to 12 cm in general cases.

19.5.4 Air content of air-entrained concrete

(1) As a rule, lightweight aggregate concrete shall be air-entrained concrete with

an air content of 1 % higher than normal weight concrete.

19.6.2 Conveying

(3) When lightweight Aggregate concrete is conveyed by a concrete pump, superplasticizer shall be used, as a rule, based on the JSCE Recommendations "Recommended Practice for Superplasticized Concrete" and "Manual of the Design and Construction for Lightweight Aggregate Concrete Structures."

[Comments]

(3) In recent years the conveyance of concrete by concrete pump has become widespread. However, with the concrete pumps in use at present the pumping of lightweight aggregate concrete is difficult unless the slump is about 17-20 cm. Therefore, concrete must be superplasticized from slump of 8-12 cm, to larger than 15 cm, to convey it by concrete pump.

CHAPTER 20 MARINE CONCRETE

20.3 Mix Proportions

20.3.1 Water-cement ratio

(1) Water-cement ratios determined on the basis of the durability of marine concrete shall follow Table 20.3.1 as a standard.

Table 20.3.1 Maximum water-cement ratio for air-entrained marine concrete (%): (durability-wise)

Zone of exposure	For general construction	For concrete products, or for cases where equivalent conditions of construction and material selection to those of concrete products are guaranteed
(a) Submerged zone	50	50
(b) Atmospheric zone	45	50
(c) Splash zone	45	45

Note: The above figures may be increased by 5 to 10 when confirmed by past experience or research study.

(2) The maximum water-cement ratio of air-entrained plain concrete may be a value which is larger than the figure in Table 20.3.1 by about 10.

20.3.2 Unit cement content

The unit cement content shall be determined in order to provide the required durability by taking into consideration the scale, importance and environmental conditions of the structure.

[Comment]

It is advisable that a minimum cement content for marine reinforced concrete structures follow Table C20.3.1 on basis of the durability of the structure.

Table C 20.3.1 Minimum unit cement content of marine concrete required for obtaining satisfactory durability (kg/m³)

Zone of exposure	Maximum size of coarse aggregate (mm)	
	25	40
Splash zone and atomospheric zone	330	300
Submerged zone	300	280

20.3.3 Air content

The air content of air-entrained concrete for marine concrete structures is indicated in the Table 20.3.2 as a standard.

Table 20.3.2 Standard air content in concrete (%)

Environmental condition		Maximum size of coarse aggregate (mm)	
		25	40
Area possibly affected by freezing and thawing	(a) Splash zone	6	5.5
	(b) Atmospheric zone	5	4.5
Area not affected by freezing and thawing		4	4

CHAPTER 21 UNDERWATER CONCRETING

21.2 Ordinary Underwater Concreting

21.2.2 Workability

In underwater concreting, concrete shall have the required high viscosity. The slump of the concrete shall follow the Table 21.2.1 as a standard.

Table 21.2.1 Standard slump for underwater concreting

Placing method (equipment)	Range of slump (cm)
Tremie, concrete pump	13−18
Bottom opening underwater bucket or bag	10−15

21.2.3 Mix proportions

(1) Water-cement ratio shall be not more than 50% as a standard.

(2) The unit cement content shall be not less than 370 kg/m³ as a standard.

21.3 Underwater Concreting for Cast-In Place Concrete Piles and Cast-In Place Diaphragm walls

21.3.1 Maximum size of coarse aggregate

The maximum size of coarse aggregate shall be not more than half the length of the clearance between the reinforcements and not more than 25 mm as a standard.

21.3.2 Workability

Concrete shall have the required high viscosity. The slump shall be of 15-21 cm as a standard.

21.3.3 Mix proportions

(1) The water-cement ratio shall be not more than 55 % as a standard.

(2) The unit cement content shall be not less than 350 kg/m^3 as a standard.

21.3.5 Placing of concrete

(3) Concrete shall be placed up to the level which is 50 cm higher than the design surface and its excess layer shall be removed after the concrete has hardened.

CHAPTER 22 PREPLACED AGGREGATE CONCRETE

22.3 Materials

22.3.3 Aggregates

(1) Standard grading of fine aggregate is shown in Table 22.3.1. The fineness modulus of fine aggregate shall be 1.4 to 2.2.

Table 22.3.1

Nominal sieve size (mm)	Passing percentage by weight
2.5	100
1.2	90−100
0.6	60− 80
0.3	20− 50
0.15	5− 30

(2) Minimum size of coarse aggregate shall be not less than 15 mm.

22.4 Mix Proportions

22.4.1 Mix proportions of grout mortar

The mix of grout mortar shall be determined to satisfy the following requirements :

(1) In general, the flow time of grout mortar shall be 16 to 20 seconds when tested

according to the JSCE Standard "Test Method for Fludity of Grout Mortar for Preplaced Aggregate Concrete".

(2) The bleeding shall not be more than 3% after three hours aging when tested according to the JSCE Standard "Test Method for Bleeding and Expansion of Grout Mortar for Preplaced Aggregate Concrete".

(3) In general, the expansion shall be 5 to 10% after three hours aging when tested according to the JSCE Standard, stated in (2).

(4) Compressive strength shall acheive the required strength when tested according to the JSCE Standard "Test Method for Compressive Strength of Preplaced Aggregate Concrete".

22.7 Grouting

22.7.2 Grouting pipes and their arrangement

(2) In general, the horizontal spacing between vertical injection pipes is to be approximately 2 meters.

(3) In general, the horizontal and vertical spacing for horizontal injection pipes shall be approximately 2 and 1.5 meters respectively. As a rule, horizontal injection pipes shall have valves to prevent backflow.

22.7.5 Grouting

(1) The grouting mortar shall be injected continuously until the mortar surface has reached the elevation designated in the design or construction plan.

(2) Mortar shall be injected from the lowest point and the rising rate of the mortar surface shall be 0.3 to 2.0 m/hr.

(3) As a rule, mortar shall be injected by vertical injection pipes by withdrawing the pipes so as to keep the lower end of the pipes inserted in the mortar, 0.5 to 2.0 meters below the mortar surface.

22.8 Large Quantity Preplaced Aggregate Concrete

22.8.1 Scope of application

This section provides the general requirements for essential items when using preplaced aggregate concrete in a large-scale construction which requires large quantities of concrete and the rapid execution of the work.

[Comment]

This section deals with the standard practices for large scale preplaced aggregate concrete construction which is defined as the concrete placing rate is not less than 40 to 80 m^3/hour or placing area is not less than 50 to 250 m^2.

22.8.2 Coarse aggregate

The minimum size of coarse aggregate for large quantity preplaced aggregate concrete shall not be less than about 40 mm.

22.9 High-Strength Preplaced Aggregate Concrete

22.9.1 Scope of application

This section provides the general requirements for high-strength preplaced aggregate concrete that uses grout mortar with a high range water-reducing agent.

[Comment]

In this section, high-strength preplaced aggregate concrete means concrete with the compressive strength of 400 to 600 kgf/cm^2 at 91 days and with the water-cementitious material ratio of less than 40 % using a high range water-reducing agent.

22.9.3 Mix proportions of grout mortar

(1) In general, the flow time of the grout mortar shall be 25 to 50 seconds when tested according to the JSCE Standard "Test Method for Flow of Grout Mortar for Preplaced Aggregate Concrete".

(2) In general, the expansion ratio shall be 2 to 5 % after three hours aging when tested according to the JSCE Standard "Test Method for Bleeding and Expansion of Grout Mortar for Preplaced Aggregate Concrete".

(3) The bleeding ratio shall be not more than 1 % when tested according to the JSCE Standard, stated in (2).

CHAPTER 24 CONCRETE PRODUCTS

24.3 Materials

24.3.2 Fine and coarse aggregates

(2) The maximum size of coarse aggregates shall be not more than 40 mm and shall not exceed 2/5 of minimum thickness of concrete products or 4/5 of minimum horizontal clearance between reinforcing steels.

24.10 Control and Inspection

24.10.3 Tests and inspection of concrete products

(1) In principle, cracking loads, ultimate loads and other necessary properties of concrete products shall be ensured by full-scale testing. When it is found that such testing is unable to be performed on certain concrete products, test specimens which enable the required quality testing shall be employed.

CHAPTER 25 PRESTRESSED CONCRETE

25.2.5 Grout for prestressed concrete

(2) In general, the quality of the grout should satisfy the following conditions. The test methods shall comply with the JSCE standard "Method of Test for Grout for

Prestressed Concrete".

(a) Consistency

The consistency shall be determined by considering the length and shape of the ducts, the construction season and weather conditions, the kind of steel material and the proportion of the sectional area of the prestressing steel to that of the duct. The standard method of consistency measurement shall conform to the JA funnel method.

(b) Expansion Rate

The expansion rate shall not be more than 10 percent.

However, the expansion rate after grouting shall always exceed the bleeding rate until bleeding reaches its maximum. In general, the standard period of time from the completion of agitation to the end of the injection should be around 30 minutes.

(c) Bleeding Rate

The bleeding rate shall not be more than 3 percent.

(d) Strength

The compressive strength at an age of 28 days shall not be less than 200 kgf/cm^2.

(6) Water-cement ratio of the grout shall not be more than 45 percent.

25.5 Prestressing

25.5.3 Required compressive strength of concrete when prestressing

(1) The required compressive strength of concrete at prestressing shall be more than 1.7 times the maximum compressive stress which occurs in the concrete just after prestressing.

For the pretensioning system, the concrete compressive strength shall not be less than 300 kgf/cm^2.

(2) The required compressive strength of concrete around the anchorages at prestressing shall be more than that required to resist the force resulting from anchoring.

25.6 Grouting

25.6.6 Grouting in cold weather

When grouting during cold weather, the temperature around the ducts shall be kept not less than 5°C before injection. The standard temperature of the grout during injection should be 10-25°C. The temperature of the grout shall be kept not less than 5°C at least for 5 days after injection.

CONCRETE LIBRARY OF JSCE NO. 14, MARCH 1990

PROPOSED RECOMMENDATION ON DURABILITY DESIGN FOR CONCRETE STRUCTURES

(Translated from the CONCRETE LIBRARY No. 65 published by JSCE. August 1989.)

JSCE Subcommittee on Durability Design for Concrete Structures.

Hajime OKAMURA, Chairman

Yukikazu Tsuji, Secretary

Committee Members

Masahiko KUNISHIMA
Hiroyuki IKEDA
Tadayoshi ISHIBASHI
Taketo UOMOTO
Koichi ONO
Nobuaki OTSUKI
Yoshio KAKUTA
Isao AIHARA
Koichi AYUTA
Hiroshi SHIMA
Shigetoshi KOBAYASHI
Michiaki SAKATE
Motohiko SUZUKI
Tadaaki TANABE
Junichiro NIWA
Yoichi NOJIRI
Akira HATAKEYAMA
Yasumitsu WATANABE
Koji TAKEWAKA
Takeshi YAMATO