JIS

JAPANESE INDUSTRIAL STANDARD

Ready-mixed concrete

㉿ JIS A 5308 -1993

Translated and Published

by

Japanese Standards Association

In the event of any doubt arising,
the original Standard in Japanese is to be final authority.

Contents

1.   Scope   This Japanese Industrial Standard specifies the ready-mixed concrete ([1]) (hereafter referred to as "ready-mixed concrete") delivered to the point of discharge.

   Note ([1])   This Standard does not specify transportation, placement and curing of the concrete after delivery.

   Remarks 1.   The standards cited in this Standard are shown in Attached Table 1.

   2.   The units and numerical values given in ( ) in this Standard are based on the International System of Units (SI) and are appended for informative reference.

        And, the traditional units and numerical values in this Standard, shall be changed to the SI units and numerical values from April 1, 1995.

2.   Types   The types of ready-mixed concrete shall be classified into ordinary concrete, lightweight concrete and road concrete, and shall be those indicated by ○ marks in Table 1 and Table 2, which are combined with the maximum size of coarse aggregates, slump and nominal strength.

   As for the following items, the purchaser can designate by the agreement with the producer.

   (1)   Type of cement
   (2)   Type of aggregates
   (3)   Maximum size of coarse aggregates
   (4)   Class of aggregates according to alkali-silica reactivity.   Method of restraining alkali-aggregate reactivity if Class B aggregates are used.
   (5)   Type of admixture materials
   (6)   Upper limit of chloride content when it differs from that prescribed in 3.2
   (7)   Material age that guarantees nominal strength
   (8)   Air content when it differs from that prescribed in Table 4.
   (9)   In the case of lightweight concrete, unit mass of concrete
   (10)   Highest or lowest temperature of the concrete
   (11)   Upper limit of water-cement ratio
   (12)   Upper limit of unit water content
   (13)   Lower or upper limit of unit cement content
   (14)   In the case of flowing concrete, the increased value of slump from the ready-mixed concrete before flowing ([2])

Note (²) In the case where the purchaser designates the method based on the total alkali content in (4), he shall inform the producer on the alkali content (kg/m³) intermixed through the use of a plasticizing admixture.

(15) Other requirements

Remarks: Items (1) to (6) shall be designated within the ranges specified in this Standard.

Table 1. Types of ready-mixed concrete

(Apply until March 31, 1995)

Type of concrete	Max. size of coarse aggregates mm	Slump cm	Nominal strength											
			160	180	195	210	225	240	255	270	300	350	400	Flexure 45
Ordinary concrete	20, 25	5	O(³)	—	—	—	—	—	—	—	—	—	—	—
		8, 10, 12	O	O	—	O	O	O	O	O	O	O	O	—
		15, 18	—	O	—	O	O	O	O	O	O	O	O	—
		21	—	—	—	O	O	O	O	O	O	—	—	—
	10	5	O	O	—	O	O	O	—	O	O	—	—	
		8	O	O	O(³)	O	O	O	—	O	O	—	—	
		12, 15	O	O	—	O	O	O	—	O	O	—	—	
		18	—	—	—						O(³)	—		
Lightweight concrete	15, 20	8, 12, 15, 18, 21	—	O	—	O	O	O	O	O	O	—		
Road concrete	10	2.5, 6.5	—	—	—	—	—	—	—	—	—	—	—	

Note (³) Shall be abolished on April 1, 1995.

Table 2. Types of ready-mixed concrete

(Apply from April 1, 1995)

Type of concrete	Max. size of coarse aggregates mm	Slump cm	Nominal strength											
			16	18	19.5	21	22.5	24	25.5	27	30	35	40	Flexure 4.5
Ordinary concrete	20, 25	5	—	—	—	—	—	—	—	—	—	—	—	—
		8, 10, 12	O	O	—	O	O	O	O	O	O	O	O	—
		15, 18	—	O	—	O	O	O	O	O	O	O	O	—
		21	—	—	—	O	O	O	O	O	O	—	—	—
	40	5	O	O	—	O	O	O	—	O	O	—	—	—
		8	O	O	—	O	O	O	—	O	O	—	—	—
		12, 15	O	O	—	O	O	O	—	O	O	—	—	—
		18	—	—	—	—	—	—	—	—	—	—	—	—
Lightweight concrete	15, 20	8, 12, 15, 18, 21	—	O	—	O	O	O	O	O	O	—	—	—
Road concrete	40	2.5, 6.5	—	—	—	—	—	—	—	—	—	—	—	O

3. Quality

3.1　Strength, slump and air content　The strength, slump and air content of the ready-mixed concrete shall satisfy the following conditions at the point of discharge.

(1)　Strength　Strength of the ready-mixed concrete, when it is subjected to the strength tests [4] specified in 8.2, shall satisfy the following requirements:

Note　[4]　Material age of the specimen for the strength test shall be 28 days in the case of no designation of 2. (7), or the number of days designated by the purchaser.

(a)　The results of one-time test shall be 85 % or over of the nominal strength values [5] designated by the purchaser.

(b)　Mean values of the results of three-time tests shall be at least the nominal strength values [5] designated by the purchaser.

Note　[5]　The values shall be expressed by kgf/cm^2 (N/cm^2).

(2)　Slump　The slump shall be as specified in Table 3.

Table 3.　Slump

Unit: cm

Slump	Tolerances in slump
2.5	± 1
5 and 6.5	± 1.5
8 or over up to and incl. 18	± 2.5
21	± 1.5

(3)　Air content　Air content shall be as specified in Table 4. Tolerances on air content shall be as specified in Table 4, also relative to the value designated by the purchaser.

Table 4.　Air content

Unit: %

Type of concrete	Air content	Tolerances on air content
Ordinary concrete	4.5	± 1.5
Lightweight concrete	5.0	
Road concrete	4.5	

3.2 Chloride content   The chloride content in the ready-mixed concrete shall be 0.30 kg/m³ or under as chloride ion (Cl⁻) content at the point of discharge. However, it may be increased up to 0.60 kg/m³ or under with the approval of the purchaser.

4.   Volume   The volume of the ready-mixed concrete shall not fall short of the volume entered in the delivery sheet at the point of discharge.

5.   Proportion

5.1   The proportion of the ready-mixed concrete shall be determined by the producer so as to satisfy the requirements designated in 2. upon agreement with the purchaser and the quality specified in 3., as well as to pass the inspection of 9.

5.2   The producer shall submit the report on composite proportion of ready-mixed concrete shown in Table 10 to the purchaser. The submission shall, as a general rule, be made prior to the delivery of the ready-mixed concrete.

5.3   The producer, as requested by the purchaser, shall submit the data as a basis for planning concrete proportions, calculating the chloride content of the concrete and for formulating the measures for restraining alkali-reactivity of aggregates.

6.   Materials

6.1   Cement   The cement used shall conform to one of the following standards:

(1)   JIS R 5210

(2)   JIS R 5211

(3)   JIS R 5212

(4)   JIS R 5213

6.2   Aggregates   The aggregates shall conform to Annex 1.

When the aggregates of Class B in Annex 1 are used, one of the measures for restraining the alkali reactivity of aggregates specified in 3. [Restraining measures using portland cement (low alkali type)], 4. [Restraining measures using mixed cement with effects restraining alkali reactivity of aggregates] and 5. [Restraining measures by delimiting total alkali content in concrete] of Annex 6. shall be selected and put into execution.

6.3   Water   The water shall conform to Annex 9.

6.4   Admixture materials   The admixture materials shall conform to the following:

(1)   The admixture materials shall not be those which adversely affect the concrete and steel.

(2) The admixture materials shall be those which are approved by the purchaser.

(3) Fly ash, expansive additive, chemical admixture and corrosion inhibitor, if used, shall conform to the following standards:

    (a) JIS A 6201

    (b) JIS A 6202

    (c) JIS A 6204

    (d) JIS A 6205

7. Manufacturing methods

7.1 Manufacturing equipment

7.1.1 Equipment for storing materials   The equipment for storing materials shall be as given in the following:

(1) The equipment for storing cement shall be divided by manufacturers and types, and be capable of preventing the cement from weathering.

(2) The storing equipment for aggregates shall be comparted according to the types and classes, and be capable of preventing segregation of large and small particles. The floor shall be constructed of concrete and the like, and measures shall be taken for drainage as well as for prevention of ingress of foreign matters ([6]).

    In addition, the equipment shall be capable of storing the amount of aggregates corresponding to the maximum delivery for one day or over of the concrete.

    Note ([6]) In the case of storing artificial lightweight aggregates, it is necessary to provide sprinkling equipment.

(3) The storing equipment and the equipment for transporting the aggregates from the storing equipment to the batching plant shall be capable of furnishing uniform aggregates.

(4) The storing equipment for admixture materials shall be comparted according to the types and classes, and shall prevent the deterioration of the quality of the admixture materials.

7.1.2 Batching plant   The batching plant shall be as follows:

(1) The plant shall generally be provided with separated storing bins for respective materials.

(2) The measuring devices shall have precision for weighing out respective materials within errors specified in 7.2.

    In addition, they shall be provided with indicating devices capable of indicating the measured values with the precision mentioned above.

(3) All the indicating devices shall be located at places visible to the operator, and the measuring devices shall ensure easy operation.

(4) The measuring devices shall be capable of successively measuring the materials for concrete of different proportions.

(5) The measuring devices shall be provided with devices which readily correct the measured values by the surface water content of fine aggregates.

7.1.3 <u>Mixer</u>   The mixer shall be as given in the following:

(1) The mixer shall be of a stationary type.

(2) The mixer, when mixing the concrete of a defined slump at the volume specified in 7.3 (2) shall be capable of mixing the materials thoroughly and discharging them under a uniform condition ([7]).

> Note ([7]) The mixer may be considered to possess performance of mixing the concrete uniformly, when a defined volume is mixed for a defined time and the values obtained by the tests in accordance with JIS A 1119 do not exceed the values given below.
>
>> Mass difference in unit volume of mortar contained in concrete ··· 0.8 %
>>
>> Difference in unit coarse aggregate quantities contained in concrete ··· 5 %

7.1.4 <u>Transport vehicle</u>   The transport vehicle shall be as given in the following:

(1) In the transportation of the ready-mixed concrete, a truck agitator having the following performances shall be used.

(a) The transport vehicle shall be capable of maintaining a thorough uniformity of the mixed concrete, and of discharging it readily and completely without causing segregation of materials.

(b) The transport vehicle, when the slump test is carried out on the samples taken ([8]) from about $\frac{1}{4}$ and about $\frac{3}{4}$ of the depth of the load, shall have such performance that the difference of slumps between the two samples is within 3 cm.

> Note ([8]) In this case, samples shall be taken as in cutting the full section of the respective part in the flow of concrete being unloaded.

(2) The dump truck can be used only for transporting road concrete having a slump of 2.5 cm.

The bed of the dump truck shall be flat, smooth and waterproof and, as required, shall have a waterproof cover for protection from rain and wind.

7.2 Measurement of materials

7.2.1 Measuring methods
The measuring methods shall be as given in the following:

(1) The cement, aggregates, water and admixture materials shall be measured respectively with separate measuring devices.

And, water may be measured cumulatively with the chemical admixtures which have been measured in advance.

(2) Measurement of cement, aggregates and admixture materials shall be in mass. With the approval of the purchaser, measurement of the admixture materials may be made by the number of bags. However, in the case where a quantity less than one bag is used, it shall be measured in mass without fail.

(3) Measurement of water and chemical admixtures shall be in mass or in volume. However, chemical admixtures shall be measured in the form of solution.

7.2.2 Measuring error
The measuring error shall be as given in the following:

(1) The measuring errors of the cement, aggregates, water and admixture materials shall be as given in Table 5. for one measuring quantity.

Table 5. Measuring error of the materials

Type of material	Measuring error for one measuring quantity %
Cement	± 1
Aggregate	± 3
Water	± 1
Admixture material	± 2
Chemical admixture	± 3

(2) Calculations of measuring errors shall be made by the following formula, and rounded off to integers by JIS Z 8401.

$$m_0 = \frac{m_2 - m_1}{m_1} \times 100$$

where, m_0 : measuring error (%)

m_1 : aimed one measuring quantity

m_2 : measured out value

7.3 <u>Mixing</u> The mixing shall be as follows:

(1) The ready-mixed concrete shall be mixed uniformly in the plant with the mixer specified in 7.1.3.

(2) Mixing quantity and mixing time of the concrete shall be determined after carrying out the test as specified in JIS A 1119 [7].

7.4 <u>Transportation</u> The transportation of the ready-mixed concrete shall be made as follows:

(1) The transportation of the ready-mixed concrete shall be made by the transport vehicle specified in 7.1.4.

(2) The concrete shall be transported so as to be discharged within 1.5 h from the start of mixing. However, upon agreement with the purchaser, the limit of the transporting time may be altered.

(3) In the case of transportation of concrete with a dump truck, the limit of the transporting time shall be 1 h from the start of mixing.

7.5 <u>Quality control</u> The producer shall conduct necessary quality control for guaranteeing the quality of concrete specified in 3.

And, the producer, as requested by the purchaser, shall submit the test results of the quality control tests.

8. Test methods

8.1 <u>Sampling method</u> The sampling method shall be in accordance with JIS A 1115. However, when samples are to be taken from a truck agitator, they may be obtained after the concrete is mixed at high speed for 30 s with the truck agitator, from a full section of the flow of concrete with the exception of 50 l to 100 l of concrete discharged first.

8.2 <u>Strength</u>

8.2.1 <u>Compressive strength</u> The compressive strength test shall be performed in accordance with JIS A 1132 and JIS A 1108.

And the dimensions of specimens shall generally be 10 cm in diameter and 20 cm in height for the coarse aggregates having maximum size of 15 mm, 20 mm or 25 mm, and shall be 12.5 cm in diameter and 25 cm in height or 15 cm in diameter and 30 cm in height for the coarse aggregates having maximum size of 40 mm.

The specimens shall be subjected to the water curing at 20 ± 3°C [9].

Note [9] In the case where the accumulated temperature method is to be used for the winter concreting, the curing of the specimen shall be the water curing at 20 ± 2°C.

Remarks: Before March 31, 1995, when the test equipment in which the weight load is indicated by SI unit is used, the compressive strength is obtained by the following: Divide the measured maximum weight load by 9.80665, round it off by JIS Z 8401 to the significant figures of 3 digits, and taking this value as "maximum weight load indicated by the test equipment" by the traditional unit, calculate the compressive strength by the formula of JIS A 1108.

8.2.2 **Flexural strength** The flexural strength test shall be performed in accordance with JIS A 1132 and JIS A 1106.

The specimens shall be subjected to the water curing at 20 ± 3°C (⁹).

Remarks: Before March 31, 1995, when the test equipment in which the weight load is indicated by SI units, is used, the flexural strength is obtained by the following: Divide the measured maximum weight load by 9.80665, round it off by JIS Z 8401 to the significant figures of 3 digits, and taking this value as "maximum weight load indicated by the test equipment" by the traditional unit, calculate the flexural strength by the formula of JIS A 1106.

8.3 **Slump** The slump test shall be in accordance with JIS A 1101.

8.4 **Air content** The air content test shall be in accordance with one of JIS A 1128, JIS A 1118 or JIS A 1116.

8.5 **Chloride content** The chloride content of the concrete shall be determined as the product of the chloride ion concentration in water in the freshly mixed concrete and the unit water content (¹⁰) used in designing the proportion. The test of the chloride ion concentration in water in the freshly mixed concrete shall be carried out in accordance with Annex 5. However, the chloride ion concentration test may, by permission of purchaser, be performed using a salt content measuring apparatus with known accuracy.

Note (¹⁰) This shall be the value shown in Proportion Table of Table 10 (report on proportion of ready-mixed concrete).

8.6 **Volume** The volume of the ready-mixed concrete shall be obtained by dividing a total loaded mass of one transport vehicle by the unit volume mass. The total loaded mass of one transport vehicle shall be calculated either as the total sum of the masses of all the materials used in its load, or from the difference of masses of the transport vehicle before and after discharge.

Remarks: The test for unit volume mass shall be in accordance with JIS A 1116. However, when the volume of the vessel by JIS A 1128 is known exactly, the vessel may be used.

9. Inspection

9.1 Inspection items The inspection shall be carried out on the strength, slump, air content and chloride content.

9.2 Strength The concrete shall be subjected to the strength test of 8.2, with the size of an inspection lot determined by agreement between the purchaser and supplier, and the product conforming to the requirements of 3.1 (1) shall be judged acceptable.

The number of tests shall generally be one per 150 m³.

The results of one-time test shall be expressed by a mean test value of three specimens prepared from a sample taken from an arbitrary transport vehicle.

9.3 Slump and air content The slump test and the air content test shall be carried out in accordance with 8.3 and 8.4, as required, and the product conforming respectively to the specifications of 3.1 (2) and 3.1 (3) shall be judged acceptable. In these tests, when the results of one or both of the slump and air content tests fail out of the allowance of them, a new sample shall be taken in accordance with 8.1, and shall be subjected to test for only one-time in accordance with 8.3 and 8.4, and if the results conform respectively to the specifications of 3.1 (2) and 3.1 (3), it shall be judged acceptable.

9.4 Chloride content The inspection method for chloride content of the concrete shall be determined by agreement between the purchaser and supplier and carried out according to 8.5, and the product conforming to the requirements of 3.2 shall be judged acceptable.

> Remarks: The inspection on the chloride content may be made at the time of shipment from the plant, because it should be possible enough to satisfy the specified conditions even at the point of discharge.

9.5 Designated items The items designated in 2. by the purchaser shall be matters for inspection to be made by agreement between the purchaser and supplier.

10. Designation The ready-mixed concrete shall be designated by symbols by type of concrete, and symbols by nominal strength, slump, and maximum size of coarse aggregates, and symbol by type of cement.

Example: Ordinary   210   8   20   N

Lightweight Class 2   270   21   15   H

- Symbol by type of cement
- Symbol by maximum size of coarse aggregates
- Slump
- Nominal strength
- Symbol by type of concrete
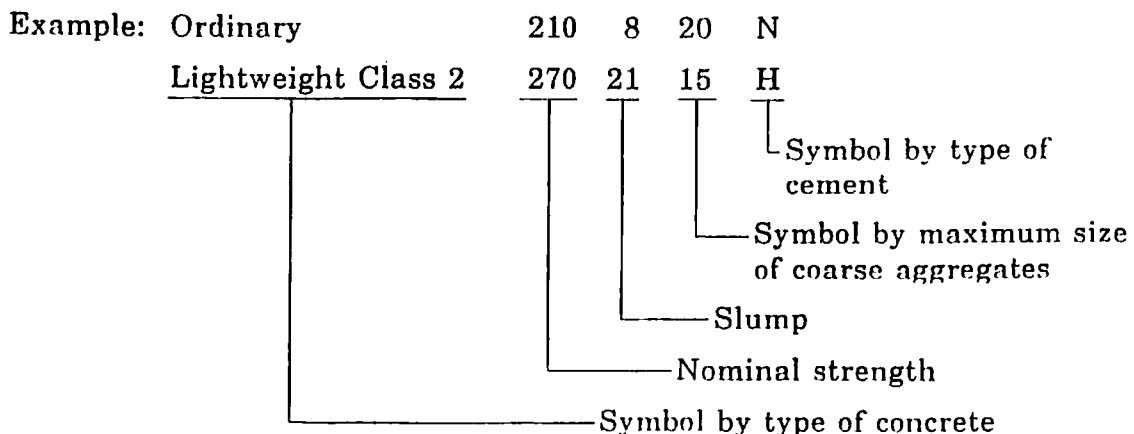
The symbols to be used for designating the ready-mixed concrete shall be as shown in Table 6 to Table 8.

Table 6. Symbol by type of concrete

Type of concrete	Coarse aggregates	Fine aggregates	Symbol
Ordinary concrete	Gravel, crushed stone or blast-furnace slag coarse aggregates	Sand, crushed sand, blast-furnace slag fine aggregates or ferro-nickel slag fine aggregates	Ordinary
Lightweight concrete	Artificial lightweight coarse aggregates	Sand, crushed sand, blast-furnace slag fine aggregates or ferro-nickel slag fine aggregates	Lightweight Class 1
	Artificial lightweight coarse aggregates	Artificial lightweight fine aggregates, or artificial lightweight fine aggregates partially mixed with sand, crushed sand or blast-furnace slag fine aggregates or mixed with ferro-nickel slag fine aggregates	Lightweight Class 2
Road concrete	Gravel, crushed stone or blast-furnace slag coarse aggregates	Sand, crushed sand, blast-furnace slag fine aggregates or ferro-nickel slag fine aggregates	Road

Table 7. Symbol by maximum size of coarse aggregates

Maximum size of coarse aggregates	Symbol
15 mm	15
20 mm	20
25 mm	25
40 mm	40

Table 8. Symbols by types of cement

Type	Symbol
Ordinary portland cement	N
Ordinary portland cement (low alkali type)	NL
High-early-strength portland cement	H
High-early-strength portland cement (low alkali type)	HL
Ultra high-early-strength portland cement	UH
Ultra high-early-strength portland cement (low alkali type)	UHL
Moderate heat portland cement	M
Moderate heat portland cement (low alkali type)	ML
Sulfate-resisting portland cement	SR
Sulfate resisting portland cement (low alkali type)	SRL
Portland blast-furnace slag cement Class A	BA
Portland blast-furnace slag cement Class B	BB
Portland blast-furnace slag cement Class C	BC
Portland pozzolan cement Class A	SA
Portland pozzolan cement Class B	SB
Portland pozzolan cement Class C	SC
Portland fly-ash cement Class A	FA
Portland fly-ash cement Class B	FB
Portland fly-ash cement Class C	FC

11. Report

11.1 Delivery sheet for ready-mixed concrete The producer shall submit the delivery sheet to the purchaser on each occasion of transportation for each transport vehicle. The standard form of the delivery sheet for ready-mixed concrete shall be as shown in Table 9.

11.2 Report on proportion of ready-mixed concrete and basic information The producer shall submit the report on proportion of ready-mixed concrete to the purchaser as shown in 5.2 (refer to Table 10).

And the producer, on request of the purchaser, shall present the basic informations on design of proportion and the like as shown in 5.3.

Table 9

Delivery Sheet for Ready-mixed Concrete					

No. ___

Month ___ day ___ year ___

Mr. _____

Name of manufacturer and plant

Place of delivery					
Transport vehicle number					
Time of delivery	Departure	(To the minute)			
	Arrival	(To the minute)			
Delivery volume			m³	Total	m³
Designation	Symbol by type of concrete	Nominal strength	Slump	Symbol by maximum size of coarse aggregates	Symbol by type of cement
Receiving officer's signature			Shipping person's signature		
Remarks					

Remarks: Size of form shall be A 5 (148 × 210 mm) or B 6 (128 × 182 mm) specified in JIS.

Table 10

Report on Proportaion of Ready-mixed Concrete

No. _____

Month _____ day _____ year _____

Mr. _____

Name of manufacturer and plant _____

Name of person in charge of proportioning	

Name of work	
Location	
Appointed time of delivery	
Applicable period of this proportion	
Placing point of concrete	

Designing conditios of proportion

Designa-tion	Symbol by type of concrete	Nominal strength	Slump	Symbol by maximum size of coarse aggregates	Symbol by type of cement

Designated items ([17])	Unit mass of lightweight concrete	(kg/m³) (t/m³)	Air contnet	%
	Temperature of concrete	Highest Lowest ·C	Types of admixture materials	
	Material age guaranteeing nominal strength	day	Method of restraining alkali reactivity of aggregates ([12])	
	Upper limit value of water cement ratio	%	Upper or lower limit value of unit mass of cement	kg/m³
	Upper limit value of unit water content	kg/m³	Chloride content in concrete	kg/m³ max.
	Increase in slump value after plasticized	cm		

Materials used ([17])

Cement	Name of manufacturer		Specific gravity		Na₂Oeq % ([14])	
Fine aggre-gates	Origin or designation	Class by ASR ([15])		Fineness modulus	Specific gravity	Absolute dry / Surface dry / Absolute dry / Surface dry
Coarse aggre-gates	Origin or designation	Class by ASR ([15])		Percentage of absolute volume or fineness modulus	Specific gravity	Absolute dry / Surface dry / Absolute dry / Surface dry
Chemical admixture	Name of product	Type		Chloride content of fine aggregates		%
Admixture materials	Name of product	Type		Class of water		

Proportion Table (kg/m³) ([16])

Cement	Water	Fine aggregates	Fine aggregates	Coarse aggregates	Coarse aggregates	Chemical admixture	Admixture materials

Water-cement ratio	%	Percentage of fine aggregates	%			

Remarks

Notes (11) Particularly designated items other than those given in the column of designation shall be entered.

(12) With symbols in Annex 6 Table 1 shall be entered. However, when the aggregates of Class A in Annex 1 are used, symbol A shall be entered in that column.

(13) Materials used in proportion designing shall be entered.

(14) Enter only when the portland cement is used.

(15) The class by alkali-silica reactivity (ASR) and the test method used for determination shall be entered.

(16) This column shall be expressed by the mass of absolute dry condition for artificial lightweight aggregates, and by the mass of saturated surface dry conditions for other aggregates.

Remarks: Size of form shall be A 4 (210 × 297 mm) or B 5 (182 × 257 mm) specified in JIS.

Attached Table 1. Cited standards

JIS A 1101 Method of test for slump of concrete

JIS A 1102 Method of test for sieve analysis of aggregates

JIS A 1103 Method of test for amount of material passing standard sieve 75 μm in aggregates

JIS A 1104 Method of test for unit weight of aggregate and solid content in aggregate

JIS A 1105 Method of test for organic impurities in fine aggregate

JIS A 1106 Method of test for flexural strength of concrete

JIS A 1108 Method of test for compressive strength of concrete

JIS A 1109 Method of test for specific gravity and absorption of fine aggregate

JIS A 1110 Method of test for specific gravity and absorption of coarse aggregates

JIS A 1115 Method of sampling fresh concrete

JIS A 1116 Method of test for unit weight and air content (gravimetric) of fresh concrete

JIS A 1118 Method of test for air content of fresh concrete by the volumetric method

JIS A 1119 Method of test for variability of constituents in freshly mixed concrete

JIS A 1121 Method of test for resistance to abrasion of coarse aggregates by use of the Los Angeles machine

JIS A 1122 Method of test for soundness of aggregates by use of sodium sulfate

JIS A 1126 Method of test for soft particles in coarse aggregates by use of scratch tester

JIS A 1128 Method of test for air content of fresh concrete by pressure method

JIS A 1129 Methods of test for length change of mortar and concrete

JIS A 1132 Method of making and curing concrete specimens

JIS A 1134 Methods of test for bulk specific gravity and absorption of light weight fine aggregates for structural concrete

JIS A 1135 Methods of test for bulk specific gravity and absorption of light weight coarse aggregates for structural concrete

JIS A 1137 Method of test for clay contained in aggregates

JIS A 5002 Light weight aggregates for structural concrete

JIS A 5005 Crushed stone and manufactured sand concrete

JIS A 5011 Slag aggregate for concrete

JIS A 6201 Fly ash

JIS A 6202 Expansive additive for concrete

JIS A 6204	Chemical admixtures for concrete
JIS A 6205	Corrosion inhibitor for reinforcing steel in concrete
JIS B 7503	Dial gauges reading in 0.01 mm
JIS K 0101	Testing methods for industrial water
JIS K 0113	General rules for methods of potentiometric, amperometric, coulometric, and Karl-Fischer titrations
JIS K 8576	Sodium hydroxide
JIS P 3801	Filter paper (for chemical analysis)
JIS R 5201	Physical testing methods for cement
JIS R 5202	Method for chemical analysis of portland cement
JIS R 5210	Portland cement
JIS R 5211	Portland blast-furnace slag cement
JIS R 5212	Portland pozzolan cement
JIS R 5213	Portland fly-ash cement
JIS Z 8401	Rules for rounding off of numerical values
JIS Z 8801	Test sieves

Annex 1. Aggregates for ready-mixed concrete

1. <u>Scope</u>   This Annex specifies the aggregates for ready-mixed concrete (hereafter referred to as "aggregates").

2. <u>Types</u>   Types of the aggregates shall be crushed stone, crushed sand, slag aggregates, artificial lightweight aggregates, gravel and sand.

3. <u>Crushed stone and crushed sand</u>   The crushed stone and crushed sand shall be those given below as specified in JIS A 5005.

(1)   Crushed stone

    (a)   Crushed stone   4005

    (b)   Crushed stone   2505

    (c)   Crushed stone   2005

    (d)   Crushed stone   4020 ([1])

    (e)   Crushed stone   2515 ([1])

    (f)   Crushed stone   2015 ([1])

    (g)   Crushed stone   1505 ([1])

    In addition, the limit of abrasion loss for those to be used in pavement slabs shall be 35 %, and the limit of quantity of soft stone flake content shall be 5.0 %.

    Note ([1])   It shall be used in mixing, and the particle size of the mixed one shall conform to 4005, 2505 or 2005 in Table 4 of JIS A 5005.

(2)   <u>Crushed sand</u>   For the crushed sand for pavement slabs and concrete of which surfaces undergo abrading action, the limit of loss in the washing test shall be 5.0 %.

4. <u>Slag aggregates</u>   The slag aggregates shall be those given below as specified in JIS A 5011.

(1)   <u>Blast-furnace slag coarse aggregates</u>

    (a)   Blast-furnace slag coarse aggregates   4005

    (b)   Blast-furnace slag coarse aggregates   2505

    (c)   Blast-furnace slag coarse aggregates   2005

    (d)   Blast-furnace slag coarse aggregates   4020 ([2])

    Further, the limit of loss in the washing test shall be 5.0 % ([3]).

    In addition, the limit of abrasion loss for those to be used in pavement slabs shall be 35 %.

Notes (2) It shall be used in mixing, and the particle size of the mixed one shall conform to 4005 in Table 7 of JIS A 5011.

(3) This specification shall be applied by the designation of the purchaser.

(2)   **Blast-furnace slag fine aggregates**

      (a)   5 mm blast-furnace fine aggregates

      (b)   2.5 mm blast-furnace slag fine aggregates

      (c)   1.2 mm blast-furnace slag fine aggregates

      (d)   5 mm to 0.3 mm blast-furnace slag fine aggregates

Further, the limit of loss in the washing test shall be 7.0 % (3).

In addition, for those to be used in pavement slabs and concrete of which surfaces undergo abrading action, the limit of loss in the washing test shall be 5.0 %.

(3)   **Ferro-nickel slag fine aggregates**

      (a)   5 mm ferro-nickel slag fine aggregates

      (b)   2.5 mm ferro-nickel slag fine aggregates

      (c)   1.2 mm ferro-nickel slag fine aggregates

      (d)   5 mm to 0.3 mm ferro-nickel slag fine aggregates

Further, for those to be used in pavement slabs and concrete of which surfaces undergo abrading action, the limit of loss in the washing test shall be 5.0 %.

5.   **Artificial lightweight aggregates**   The artificial lightweight aggregates shall be those given below as specified in JIS A 5002.

(1)   Classification by specific gravity of aggregates under absolute dry condition
: M, H (3)

(2)   Classification by percentage of absolute volume of aggregates
: A, B (3)

(3)   Classification by compressive strength as concrete : 200 (3), 300, 400

(4)   Classification by unit mass of concrete   : 15 (3), 17, 19 (3), 21 (3)

Further, the limit for floating particle rate of the coarse aggregates shall be 10.0 %.

6.   **Gravel and sand**

6.1   Gravel and sand shall be clean, strong fire-proof, durable, and shall not include injurious amounts of dust, mud, organic impurities or others.

6.2   Particle sizes of gravel and sand shall be the proper mixtures of large and small particles, and the standard of the particle size shall be within the range of Annex 1 Table 1.

Annex 1 Table 1. Standard particle sizes of gravel and sand

Type of aggregates			Mass percentage of particles which pass through the sieves %												
			Nominal size of sieve (4) mm												
			50	40	30	25	20	15	10	5	2.5	1.2	0.6	0.3	0.15
Gravel	Maximum size mm	10	100	95 to 100	—	—	35 to 70	—	10 to 30	0 to 5	—	—	—	—	—
		25	—	—	100	95 to 100	—	30 to 70	—	0 to 10	0 to 5	—	—	—	—
		20	—	—	—	100	90 to 100	—	20 to 55	0 to 10	0 to 5	—	—	—	—
Sand			—	—	—	—	—	—	100	90 to 100	80 to 100	50 to 90	25 to 65	10 to 35	2 to 10

Note (4) Nominal sizes of sieves shall be respectively mesh sieve of 53 mm, 37.5 mm, 31.5 mm, 26.5 mm, 19 mm, 16 mm, 9.5 mm, 4.75 mm, 2.36 mm, 1.18 mm, 600 μm, 300 μm and 150 μm as specified in JIS Z 8801.

6.3 The quality of the gravel and the sand shall be as shown in Annex 1 Table 2.

Annex 1 Table 2. Qualities of gravel and sand

Quality item	Gravel	Sand
Specific gravity under absolute dry condition (3)	2.5 min. (5)	2.5 min. (5)
Percentage of water absorption % (3)	3.0 max. (6)	3.5 max. (6)
Amount of clay lumps %	0.25 max.	1.0 max.
Loss in washing test %	1.0 max.	3.0 max. (7)
Organic impurities (8)	—	Not darker than the standard colour solution (9)
Soft stone flakes % (10)	5.0 max.	—
Coal, lignite and the like which float in the liquid of specific gravity 1.95 % (3)	0.5 max. (11)	0.5 max. (11)
Chloride content % (12)	—	0.04 max. (13)

Notes (5) With the approval of the purchaser, it can be altered to 2.4 or over.

(6) With the approval of the purchaser, it can be altered to 4.0 % or under.

(7) In the case of concrete of which surface does not undergo abrading action, it shall be 5.0 % or under.

(8) This test shall be carried out by JIS A 1105.

(9) Even when colour of the solution on the upper part of sand is darker than the standard colour, if the compression strength ratio in the method of sand testing by the compressive strength of mortar specified in Annex 3, is not less than 90 %, it may be used by the approval of the purchaser.

(^{10}) Applied for pavement slabs and when especially required the hardness on the surface.

(^{11}) When the appearance of concrete is not so important, it may be within 1.0 %.

(^{12}) For the mass of sand in absolute dry condition, it shall be indicated by the value replaced to NaCl.

(^{13}) For those over 0.04 %, approval of the purchaser shall be required. However, the limit of them shall be 0.1 %. When to be used for the pretension-prestressed concrete part materials, they shall be not more than 0.02 %, and with the approval of the purchaser they may be not more than 0.03 %.

Remarks 1. Durability of aggregates, if required by the purchaser, shall be judged by carrying out of the stability test. When the operations are repeated 5 times, the limit loss of mass of gravel and sand shall be respectively 12 % and 10 %.

2. When used for pavement slabs, the limit of abrading loss of the gravel shall be 35 %.

7. Classification by alkali-silica reactivity   Crushed stone, crushed sand, gravel and sand shall be classified as shown in Annex 1 Table 3 by the results of alkali-silica reactivity test.

Annex 1 Table 3. Classification by alkali-silica reactivity test (^{14})

Class	Remarks
A	Those judged harmless by the results of alkali-silica reactivity test.
B	Those not judged harmless by the results of alkali-silica reactivity test or not subjected to the test.

Note (^{14}) As a rule, it shall be carried out and judged by chemical method. By this results, if it is judged as not harmless, shall be judged by carrying out the test by mortar-bar method.

And, if the test by chemical method is not carried out, it may be judged by carrying out the test by mortar-bar method.

8. In the case where aggregates are mixed for use

8.1   In the case where aggregates of the same type are mixed for use, the quality of the mixed aggregates shall conform to the requirements of 3., 4., 5. or 6.

8.2 In the case where different types of aggregates are mixed for use, the quality of the aggregates before mixing shall respectively conform to the requirements of 3., 4., 5. or 6. However, regarding the grading and chloride content, the product shall be deemed acceptable if the values of the mixed aggregates conform to the requirement of 6.

8.3 In the case where different types of aggregates are mixed for use, the types of aggregates mixed and the mixing ratio shall be indicated.

8.4 In the case where crushed stone, crushed sand, gravel and sand include some portions of those judged Class B in the alkali silica reactivity test, the whole aggregate mixture shall be treated as aggregates whose harmlessness is not yet confirmed.

9. Test methods for aggregates

9.1 The methods for testing aggregates shall be in accordance with the following standards:

(1) . JIS A 1102

(2) JIS A 1103

(3) JIS A 1104

(4) JIS A 1105

(5) JIS A 1109

(6) JIS A 1110

(7) JIS A 1121

(8) JIS A 1122

(9) JIS A 1126

(10) JIS A 1134

(11) JIS A 1135

(12) JIS A 1137 ([15])

> Note ([15]) The test shall be carried out using the sample through with the washing treatment in accordance with JIS A 1103.

9.2 The method for testing chloride content in the aggregates shall be in accordance with the specifications of 4.5 (chloride) of JIS A 5002. However, the quantity of the sample of the ordinary aggregates shall be 1000 g.

9.3 The method for testing the particles to float in the liquid 1.95 in specific gravity in the aggregates shall be in accordance with Annex 2.

9.4 The method for testing the sand through the compressive strength of mortar shall be in accordance with Annex 3.

9.5   The method for testing the rate of particles floating in the artificial lightweight coarse aggregates shall be in accordance with Annex 4.

9.6   The alkali-silica reactivity test methods shall be in accordance with Annex 7 or Annex 8.

Annex 2. Method of testing particles contained in aggregates and floating in liquid of specific gravity 1.95

1. **Scope**   This Annex specifies the testing method for approximately gauging the particles of specific gravity 1.95 or under contained in the aggregates.

2. **Test appliances**

2.1   **In the case of fine aggregates**   The appliances for testing the fine aggregates shall be as given in the following:

(1)   The balance shall be 1000 g or over in weighing capacity and capable of weighing to the nearest 0.1 g.

(2)   The sieve shall be a mesh sieve of nominal size 600 μm specified in JIS Z 8801.

(3)   Two or more small screening nets, which are made of wire gauze of 600 μm or under in nominal size specified in JIS Z 8801, shall be prepared.

(4)   Three 1000 ml glass beakers shall be prepared.

2.2   **In the case of coarse aggregates**   The appliances for testing the coarse aggregates shall be as given in the following:

(1)   The balance shall 5000 g or over in weighing capacity and capable of weighing to the nearest 0.5 g.

(2)   The vessel for the test solution and the wire gauze basket for the aggregates shall not be corroded by the solution, and the capacity of the vessel shall be so arranged that, when the sample is immersed in it, the surface of the solution remains at least 5 cm above the upper surface of the sample.

(3)   Two or more small screening nets, which are made of wire gauze of 2.36 mm or under in nominal size specified in JIS Z 8801, shall be prepared.

(4)   A spoon for stirring of an appropriate size shall serve.

3. **Test solution**   The solution to be used for test shall be a zinc chloride solution ($ZnCl_2$) 1.95 ± 0.02 in specific gravity at 21°C to 27°C.

> Informative reference: Because the zinc chloride solution of this concentration stimulates the skin and causes a burn, care shall be taken in handling it. In case the skin has contacted it, washing with plenty of water can disinfect the skin sufficiently.

4. Sample

4.1 In the case of testing fine aggregates   Representative fine aggregates shall be sampled by the quartering method or with the sample splitter. They are to remain on a 600 μm sieve and their quantity shall be 100 g to 200 g according to the particle sizes of the sand. The sample shall be dried at 105°C to 110°C to constant mass, and then screened with the 600 μm sieve, and those remaining on the sieve shall be weighed to the nearest 0.1 g.

4.2 In the case of testing coarse aggregates   Representative coarse aggregates shall be sampled by the quartering method or other suitable methods, and their quantity shall be 2500 g. The sample shall be dried at 105°C to 110°C to constant mass, and then weighed to the nearest 0.5 g.

5. Test methods

5.1 In the case of testing fine aggregates   The method of testing the fine aggregates shall be as given in the following:

(1)   Pour 600 ml of the testing solution into a 1000 ml glass beaker, and add the sample to the solution while mixing by stirring the solution violently.

(2)   When the entire sample begins to float, stop stirring, and allow the sample to stand for about 30 s until a clear boundary is formed between the floating lightweight particles and the fine aggregates.

(3)   Pour the solution into the screening net with care to transfer only the floating particles together with the solution and to prevent the settled sand from running over the edge of the beaker.

In the case of the sample which includes a large amount of lightweight particles, add the solution to the sample excessively and carry out the operations of (2) and (3).

In this test, the sample shall not be kept in contact with the zinc chloride solution for 2.5 min or more.

(4)   Wash the particles remaining on the screening net thoroughly with clean water to eliminate the zinc chloride, then dry at 105°C to 110°C to constant mass, and weigh to the nearest 0.1 g. Inspect the dried particles with the naked eye for any sand particles remaining to remove them.

5.2 In the case of testing coarse aggregates   The method of testing the coarse aggregates shall be as given in the following:

(1)   Put the sample in the metallic basket, immerse them in the vessel containing the testing solution, and stir the sample and the solution violently for 1 min with a large mixing spoon.

(2)   Within 1 min after stopping stirring, scoop out the floating particles with the screening net.

(3)   Wash the particles which have been scooped out with clean water thoroughly to eliminate the zinc chloride, then dry at 105°C to 110°C to constant mass, and weigh to the nearest 0.5 g.

6.   Calculation   The approximate percentage value of the lightweight particles shall be calculated from the following formula:

Percentage (%) of lightweight particles

$$= \frac{\text{Mass of particles remaining on screening net}}{\text{Mass of dried sample } (^1)} \times 100 \ (^2)$$

Notes (1)   In the case of the fine aggregates, this value is the mass of the sample which has remained on the 600 μm sieve.

(2)   In this test method, particles 600 μm or under cannot be separated thoroughly.

Annex 3. Method of testing sand by compressive strength of mortar

1. Scope   This Annex specifies the method (¹) of testing the sand for which the color of testing solution in the organic impurity test has turned darker than the standard color.

> Note (¹)   This testing method shall be to conduct a comparison between the compressive strength of the mortar prepared by using the sand to be tested and that of the mortar prepared by using the same kind of sand which has been washed with 3 % solution of sodium hydroxide.

2. Test appliances

2.1   The balance shall be 2000 g or over in weighing capacity and capable of weighing to the nearest 0.5 g.

2.2   The mixer to serve shall be an electric mixer having a mixing drum 4.7 l or over in nominal capacity, and fitted with a paddle which makes a circular motion, rotates on its own axis and at the same time revolves the drum in the opposite direction. The number of rotations of the paddle shall be, in the case of low speed, 140 ± 5 rpm for self-rotation and approximately 62 rpm for drum's revolution, and in the case of high speed, 285 ± 10 rpm for self-rotation and approximately 125 rpm for drum's revolution.

2.3   The formwork shall be a metallic cylinder 5 cm in inside diameter and 10 cm in height.

2.4   The tamping rod shall be a round steel rod 9 mm in diameter the tip end of which shall be pointed bluntly.

3. Materials to be used in testing

3.1   The cement shall generally be that used in the plant.

3.2   The water shall generally be that used in the plant.

4. Sample

4.1   Representative sand shall be sampled for the test, and reduced to approximately 25 kg by the quartering method or with a sample splitter and one-third of this shall be washed with 3 % solution of sodium hydroxide (²).

> Note (²)   The guaranteed grade specified in JIS K 8576 shall be used.

4.2   In washing the sand with the sodium hydroxide solution, the sodium hydroxide solution shall be added to such an extent that the sand contained in the vessel is hidden, and after stirred thoroughly, shall be left to stand for about 1 h.

The sand which has been washed with the sodium hydroxide solution shall be washed with clean water thoroughly until alkalinity due to residual sodium hydroxide becomes undetectable. In washing the sand, a cloth of a fine texture and the like shall be used in order to prevent microparticles of sand from being lost with the running water.

4.3 The sand shall be used under the water-saturated surface-dry condition. To effect the water-saturated surface-dry condition of sand, take procedures in accordance with 3. (sample) (3) of JIS A 1109.

5. Test methods

5.1 Determination of proportion of mortar   The proportion of the mortar to be used in the tests shall be determined as given in the following, using the sample of the sand which is not washed with the sodium hydroxide solution.

Set the mixing drum and paddle to the mixer, pour 400 g of water into the mixing drum, add 800 g of the cement and mix for 40 s at a low speed. In the meantime, feed the water-saturated surface-dry conditioned test sand gradually. Next, stop for 20 s, and meanwhile scrape off the mortar adhering to the mixing drum and the paddle with a spoon. Determine the mass of the sand so that the flow of the mortar attains 190 ± 5 when it has been mixed further for 2 min at a high speed ([3]).

Note ([3]) This mass shall also be used for the washed sand.

Further, in the case of the ordinary river sand, it is about 2000 g to 2500 g.

5.2 Measurements of flow and air content of mortar   The flow test of the mortar shall be in accordance with 10.7 (measuring method of flow) of JIS R 5201.

The air content shall be calculated in accordance with 5. (calculation of results) of JIS A 1116, after obtaining the unit mass of mortar in accordance with 6.6 (unit water content ratio) of JIS A 6201 ([4]).

Furthermore, measurements of flow and air content shall be carried out for each kind of sand, and the mortar used in these measurements shall not be used in molding the specimens.

Note ([4]) The measurement of the air content gives an index for judging whether or not the sand to be used in the test is contaminated with detergents, oils and fats, humic acid, etc.

5.3 Molding of specimen

5.3.1 The mixing of the mortar shall be in accordance with 5.1. Two batches shall be mixed for each sand, and 4 specimens shall be made from each batch.

5.3.2   The mortar shall be packed in the formwork separated into two layers. Each layer shall be tamped 25 times with a tamping rod. After the tamping, hollows due to the tamping shall be leveled off by tapping the formwork lightly.

5.3.3   Capping shall be made 4 h after the packing of mortar in the formwork, and 24 h later the formwork shall be detached to allow the mortar to cure until the time of test.

The capping and curing shall be in accordance with 4.4 (upper surface finishing of specimen) and 7. (detaching of formwork and curing) of JIS A 1132.

5.4   <u>Compressive strength test</u>   The compressive strength test shall be made in accordance with JIS A 1108.

The number of specimens to be subjected to the test shall be four for each material age. The material ages shall be 7 days and 28 days for the ordinary portland cement, moderate heat portland cement and mixed cement, and 1 day and 3 days for the high-early-strength portland cement.

6.   <u>Calculation</u>   From the compressive strength of the mortar using the test sand and that of the mortar using the test sand washed with the 3 % solution of sodium hydroxide, the compressive strength ratio at each material age shall be calculated from the following formula, and the figure of one place of decimal shall be rounded off to an integer in accordance with JIS Z 8401.

Compressive strength ratio (%)

$$= \frac{\text{Compressive strength of mortar using the test sand}}{\begin{array}{c}\text{Compressive strength of mortar using the test sand washed} \\ \text{with the sodium hydroxide solution}\end{array}} \times 100$$

Annex 4. Method of testing floating particle rate
of lightweight coarse aggregates

1.   Scope   This Annex specifies the method of testing the floating particle rate of the lightweight coarse aggregates for structure.

2.   Test appliances

2.1   The balance shall be 2000 g or over in capacity, and capable of weighing to the nearest 2 g.

2.2   The vessel in which the coarse aggregates are to be immersed shall be watertight, and 24 cm or over in inside diameter and 22 cm or over in inside height.

2.3   The drying appliance used for the coarse aggregates shall be an electric thermostatic drier ([1]).

> Note ([1])   This should preferably be provided with an air stirrer and a ventilator.

2.4   The sieve to serve shall be a 5 mm ([2]) sieve.

> Note ([2])   It shall be with the mesh sieve of nominal size 4.75 mm specified in JIS Z 8801.

3.   Sample   The coarse aggregates under air-dry condition shall be screened with a 5 mm sieve, and from the aggregates remaining on the sieve, approximately 2 l shall be taken by the quartering method or with a sample splitter to serve as the sample.

4.   Test method

4.1   Dry the sample at 105°C to 110°C until it attains the constant mass.

4.2   After the dried aggregates have been left to cool to room temperature, weigh their mass (M_r) to the nearest 2 g.

4.3   Transfer the sample of which the mass has been measured into a vessel and pour water into it while stirring so that the aggregates contact water adequately and air bubbles adhering to the aggregates are removed.

4.4   Ten min after the water has been poured in, scoop out the particles floating on the water with a metal gauze and the like.

4.5   Dry again the scooped-out particles according to the method of 4.1, allow them to cool to room temperature, and then weigh the mass (M) to the nearest 2 g.

5.   Calculation

5.1   The floating particle rate shall be calculated to 0.1 % according to the following formula:

$$\text{Floating particle rate (\%)} = \frac{M}{M_r} \times 100$$

where, M :   dried mass of the scooped-out particles (g)

M_r :   mass of the dried aggregates before pouring water (g)

5.2   The test shall be carried out two times, and the results shall be expressed by the mean value.

Annex 5. Method of testing chloride ion concentration of water contained in fresh concrete

1. <u>Scope</u>   This Annex specifies the analyzing method for chloride ion concentration of water contained in concrete to obtain the chloride content in fresh concrete.

2.   <u>Sample filtrate</u>

2.1   A sample filtrate of an amount necessary for the analysis shall be taken from the representative sample of the fresh concrete of which the chloride content is to be determined.

2.2   The representative sample of the concrete shall be taken in accordance with JIS A 1115.

2.3   The filtrate shall be taken from the fresh concrete or from the mortar wet-screened from it by suction filtration or centrifugal separation, or else shall be the bleeding water from the upper surface of the fresh concrete or the mortar.

3.   <u>Analyzing method</u>   The analysis of the chloride ion (Cl-) in the sample filtrate shall be made in accordance with the mercury (II) thiocyanate absorption photometric method or the silver nitrate titration method prescribed in 32. [chloride ion (Cl-)] of JIS K 0101, or in accordance with the potentiometric titration method using chloride ion electrodes in accordance with JIS K 0113.

> Remarks: Because there may appear some disturbing ions depending on the analyzing methods, their effects shall be taken into consideration.
>
>   In the case where the silver nitrate titration method is employed, the potassium chromate may be used as an indicator.

4.   <u>Results</u>   The results of analysis shall be obtained down to three places of decimals in mass percentage.

    The test shall be performed two times on the same sample filtrate, and the mean value of the two tests rounded off to the second decimal place shall be the test result.

Annex 6. Method of restraining alkali reactivity of aggregates through selection of cement and others

1. **Scope**   This Annex specifies the method of restraining the alkali reactivity of aggregates in the case where gravel, sand, crushed stone and crushed sand of class B in Annex 1 are used as the aggregates for the ready-mixed concrete.

2. **Classification**   The measures for restraining the alkali reactivity of aggregates shall be classified as shown below:

(1)   The restraining measures using portland cement (low alkali type)

(2)   The restraining measures using mixed cement which has the restraining effect on the alkali reactivity of aggregates

(3)   The restraining measures by delimiting the total alkali content in the concrete

3. **Restraining measures using portland cement (low alkali type)**   The cement to serve shall be one of the following five types conforming to Annex to JIS R 5210.

(1)   Ordinary portland cement (low alkali type)

(2)   High-early-strength portland cement (low alkali type)

(3)   Ultra-high-early-strength portland cement (low alkali type)

(4)   Moderate heat portland cement (low alkali type)

(5)   Sulfate-resistant portland cement (low alkali type)

4. **Restraining measures using mixed cement with effects restraining alkali reactivity of aggregates**   The cement to serve shall be blast-furnace slag cement Class B or C conforming to JIS R 5211, or fly ash cement Class B or C conforming to JIS R 5213.

> Remarks: The amount (mass %) of blast-furnace slag in blast-furnace slag cement Class B shall be 40 % or over for the total alkali amount of base cement within 0.8 %, and 50 % or over for other blast-furnace cements of Class B.
>
> The amount of fly ash (mass %) in Class B fly ash cement shall be 15 % or over for the total alkali amount of base cement within 0.8 %, and 20 % for other fly ash cements of Class B.

5. **Restraining measures by delimiting total alkali content in concrete**

5.1   **Cement**   The cement to serve shall conform to JIS R 5210 and have a known total alkali [1].

> Note [1]   The total alkali in cement shall be expressed by Na_2Oeq (%), as:
>
> $$Na_2Oeq\ (\%) = Na_2O\ (\%) + 0.658K_2O\ (\%)$$

5.2 Total alkali content The total alkali content in the concrete shall be 3.0 kg/m³ ([2]) or under as calculated from the formula (1). However, in the case where only the admixture which does not greatly increase Na⁺ and K⁺ in the concrete (the admixture specified in JIS A 6204) is used, the total alkali content in the concrete shall be 2.5 kg/m³ as the limit as calculated from the formula (2) to obtain the alkali due only to the cement.

$$R_t = \frac{Na_2Oeq}{100} \times C + 0.9 \times Cl^- + R_m \cdots\cdots (1)$$

$$R_t = \frac{Na_2Oeq}{100} \times C \cdots\cdots (2)$$

where, R_t :   total alkali content (kg/m³)

      Na_2Oeq :   total alkali in the cement (%)

      C :   unit mass of cement (kg/m³)

      Cl^- :   chloride ion (Cl⁻) content obtained by the measurement of chloride in the concrete (kg/m³)

      R_m :   alkali content in the chemical admixture in the concrete (kg/m³)

Note ([2]) When the purchaser performs fluidizing of the concrete at the point of discharge, the total alkali content shall be not more than the value to be obtained by subtracting alkali content mixed in the fluidizing admixture from 3.0 kg/m³.

6. Report When the restraining measures have been duly taken in accordance with this Annex, the method employed shall be entered using the symbols of Annex 6 Table 1 in the Report on Proportion of Ready-mixed Concrete of Table 10 in the main text of this Standard by means of the symbols denoting the type of cement to serve or the kind of restraining method through delimiting the total alkali content in concrete as specified in Annex 6 Table 1.

Annex 6 Table 1. Symbols denoting restraining method

Restraining method		Symbol
3. (1)	Use of ordinary portland cement (low alkali type)	NL
3. (2)	Use of high-early-strength portland cement (low alkali type)	HL
3. (3)	Use of ultra-high-early-strength portland cement (low alkali type)	UHL
3. (4)	Use of moderate heat portland cement (low alkali type)	ML
3. (5)	Use of sulfate resisting portland cement (low alkali type)	SRL
4.	Use of blended cement (blast-furnace slag cement Class B)	BB
4.	Use of blended cement (blast-furnace slag cement Class C)	BC
4.	Use of blended cement (fly ash cement type B)	FB
4.	Use of blended cement (fly ash cement type C)	FC
5.	Delimiting total alkali content in concrete	AL (kg/m³) (³) Formula ( )

Note (³)　In ( ) after "AL", enter the calculated total alkali content rounded off to the first decimal place.

In ( ) after "Formula", enter formula (1) or formula (2) of Annex 6 whichever has been used.

Annex 7. Test method for potential alkali-silica reactivity
of aggregates (chemical method)

1. **Scope**   This Annex specifies the test method for chemically and relatively quickly estimating potential alkali-silica reactivity of aggregates by measuring the decrease in alkali concentration (Rc) and the amount of dissolved silica (Sc) in the test solution derived either from the aggregates before mixing or from the fresh concrete.

2. **Definitions**   For the purposes of this Annex, the following definitions apply:

(1)   **alkali-silica reaction (ASR)**   A phenomenon in which the substance produced by the reaction between the potentially reactive silica contained in the aggregates and the alkali in the concrete expands by absorbing water and causes a crack in the concrete.

(2)   **decrease in alkali concentration (Rc)**   The amount of alkali consumed in the reaction with the aggregates.

(3)   **amount of dissolved silica (Sc)**   The amount of silica eluted out by the reaction of the aggregates and the alkali.

(4)   **fresh concrete**   Concrete in the state not yet solidified.

3. **Sample**   The sample shall be the unused aggregates and those from fresh concrete, and generally about 40 kg each of representative samples shall be taken from coarse and fine aggregates.

> Remarks: Because some aggregates may not come up to the standards for this method, it is sometimes necessary to investigate the aggregates mineralogically beforehand.

4. **Test apparatus**   Appliances and reagents

4.1   **Apparatus and appliances for sample preparation**   The apparatus and appliances for sample preparation shall be as follows:

(1)   The crushing apparatus shall be a jaw crusher which can crush coarse aggregates to about 5 mm or under in grading.

(2)   The fine crusher shall be a crusher or an appropriate apparatus which can crush aggregates 5 mm or under in size into the state of 300 μm or under in grading.

(3)   The sieves shall be the 300 μm and 150 μm sieves specified in JIS Z 8801.

(4)   The drier shall be one which can be controlled at 105°C and continuously used for a long period of time.

4.2   **Test apparatus and appliances**   The test apparatus and appliances shall be as follows:

(1) The chemical balances shall be about 150 g in weighing capacity with reciprocal sensibility to the nearest 10 mg, and about 80 g in weighing capacity with reciprocal sensibility to the nearest 0.1 mg.

(2) The reaction vessel shall be 50 ml to 60 ml in capacity, manufactured from stainless steel or other appropriate corrosion resisting materials, and fitted with an airtight lid, and further in the event of a blank test, there shall be no silica elusion and the decrease in alkali concentration shall be under 10 mmol/l.

(3) The thermostatic water tank shall be capable of maintaining the temperature for over 24 h at 80°C ± 1.0°C under the condition that the reaction vessel is entirely immersed and kept immobile.

(4) Water bath plate (pan)

(5) Sand bath plate (pan)

(6) The photoelectric spectrophotometer or the photometric photometer shall be capable of measuring with sufficient accuracy the transmitted light in the vicinity of 410 nm in measuring wavelength.

(7) The atomic absorption photometer shall be fitted with a high temperature burner and capable of measurements using acetylene-dinitrogen-oxide gas.

(8) The electric furnace shall be capable of maintaining the temperature at the maximum temperature of 1100°C for a long period of time.

(9) The following analytical appliances shall be used:

    (a) Whole pipettes (5 ml, 10 ml, 20 ml and 25 ml)

    (b) Büchner funnel (about 60 mm in inside diameter)

    (c) Burette (25 ml)

    (d) Volumetric flasks (100 ml and 1 l)

    (e) Erlenmeyer flask (100 ml)

    (f) Beakers (100 ml and 200 ml)

    (g) Watch glass

    (h) Polyethylene vessel with ground-in stopper (30 ml to 50 ml)

    (i) Polyethylene bottles (100 ml and 1 l)

    (j) Teflon cylinder or polyethylene cylinder (10 ml)

    (k) Platinum plate (75 ml or 100 ml)

    (l) Platinum crucible (30 ml)

    (m) Desiccator

    (n) Suction filter

5. Water and reagents

5.1 Water   The water to serve shall be distilled water or the water of purity equal or superior to it.

5.2 **Reagents** The reagents to serve shall be those of the guaranteed grade specified in the pertinent JIS or those of quality equal or superior to them.

(1) 1 N {mol/l} sodium hydroxide standard solution: Shall be of 1.000 ± 0.010 N {mol/l} and standardized to ± 0.001 N {mol/l}.

(2) 0.05 N {mol/l} hydrochloric acid standard solution: Shall be of 0.05 N {mol/l} and standardized to ± 0.001N {mol/l}.

(3) Perchloric acid (60 % or 70 %)

(4) Hydrochloric acid (1 + 1)

(5) Hydrofluoric acid (about 47 %)

(6) Sulfuric acid (1 + 1)

(7) Sulfuric acid (1 + 10)

(8) Phenolphthalein indicator (1 % ethanol solution): Dissolve 1 g of phenolphthalein in 100 ml of ethanol (1 + 1) and keep in a dropping bottle.

(9) Ammonium molybdate solution (10 $^w/v$%): Dissolve 10 g of ammonium molybdate [$(NH_4)_6Mo_7O_{24}\cdot4H_2O$] in water to make 100 ml. Filter the solution through a filter paper (Class 5C specified in JIS P 3801) if the solution is not transparent. Keep this solution in a polyethylene bottle. When white precipitate appears, prepare new solution.

(10) Oxalic acid solution (10 $^w/v$%): Dissolve 10 g of oxalic acid dihydrate in water to make 100 ml. Keep this solution in a polyethylene bottle.

(11) Silica standard stock solution (SiO$_2$ 10 mmol/l): Put silicon dioxide (99.9 % or over in purity) in a porcelain crucible, and after about 1 h of igniting at 1000°C, let it cool in a desiccator. Weigh out 0.601 g of the cooled silicon dioxide into a platinum crucible (30 ml), add 3.0 g of sodium carbonate (anhydride) and mix thoroughly. After heating gradually, put the crucible into an electric furnace heated at 1000°C and fuse silicon dioxide. After cooling, put the crucible into a beaker (200 ml) containing 100 ml of warm water to dissolve the melt thoroughly. Take out the platinum crucible from the beaker after washing well. Transfer the solution to a 1 l volumetric flask and after adding water up to the marked line, keep it in a polyethylene bottle. Prepare this standard solution for each time of plotting the working curve.

6. **Preparation of sample** The sample shall be prepared as follows:

6.1 **Reduction of sample** Mix well and reduce the aggregates and prepare about 10 kg of representative sample of the aggregates.

6.2 **Coarse crushing** Crush the representative aggregates to about 5 mm or under with a crusher. Mix well and reduce the crushed aggregates, and prepare about 1 kg of representative sample.

6.3 **Preparation of representative sample** The representative sample shall be prepared as follows:

(1) Separate the particles 300 μm to 150 μm groups from the representative sample by sieving, and discard fine powder 150 μm or under.

(2) Crush the portions of coarse particles 300 μm or over in size little by little by pulverizer with care to minimize the ratio of the fine powder portions 150 μm or under.

(3) Separate the 300 μm to 150 μm particle groups from the crushed representative sample by sieving, and discard the fine powder 150 μm or under in size. Repeat the operations of (1) and (2) for the coarse particle portion 300 μm or over in size and collect the particle groups 300 μm to 150 μm.

(4) After the coarse particle portion 300 μm or over has been removed, mix the particle groups 300 μm to 150 μm in size, and wash in running water on a 150 μm sieve little by little. Rinse the sample ridded the fine powder by washing with about 1 *l* of water.

(5) Transfer the rinsed sample to an adequate vessel such as a stainless steel vat or the like, remove the excess water, and dry in a drier controlled at 105 ± 5°C for 20 ± 4 h.

(6) After the sample has been cooled, again remove the fine powder portion through a 150 μm sieve, mix the particle groups 300 μm to 150 μm in size thoroughly and use it as the test sample.

7. Test method

7.1 Procedure of reaction between alkali and aggregate sample   Add 1 N (mol/*l*) sodium hydroxide standard solution to the sample, let them react in a thermostatic water tank controlled at 80°C for 24 h, filter the solution by suction and obtain the sample stock solution. The detailed procedure for this operation shall be as follows:

(1) Weigh out 3 aliquots of 25.00 ± 0.05 g each from the sample, put them each in three reaction vessels, add 25 ml of 1 N (mol/*l*) sodium hydroxide standard solution using a whole pipette and cover immediately.

    Simultaneously operate one reaction vessel for the blank test.

(2) Rotate the reaction vessel three times on the working table horizontally and slowly in alternate directions, thereby separating the bubbles adhering to the sample.

(3) Tightly close the cover of the reaction vessel, immediately and completely immerse the vessel in the thermostatic water tank kept at 80 ± 1°C, and let it stand for 24 h ± 15 min.

(4) When the defined period of time has elapsed, take out the reaction vessel from the thermostatic water tank, and cool it with running water for 15 ± 2 min.

(5) Turn the vessel upside down two times with the cover closed tightly, allow it to stand for 5 min, open the cover, put a filter paper (Class 5, 55 mm in diameter specified in JIS P 3801) on the Büchner funnel and filter the supernatant slowly by suction. Then transfer the residue in the vessel into the Büchner funnel using a stainless steel spoon or the like, and press the residue slightly to make it level and continue sucking for 4 min. Receive the filtrate in a polyethylene vessel fitted with ground-in stopper 30 ml to 50 ml in capacity. The duration of the sucking filtration in this operation shall always be the same.

(6) Stopper the polyethylene vessel tightly containing the filtrate, mix it and then make it the sample stock solution.

Informative reference: The error will be minimized by performing the filtration on the reaction vessels one by one.

7.2 Method of determining decrease in alkali concentration

7.2.1 Procedure   Take an aliquot of the sample stock solution and add water to obtain a diluted sample solution. Take a part of this solution and titrate with 0.05 N (mol/l) hydrochloric acid standard solution using phenolphthalein indicator. The detailed procedure shall be as follows:

(1) Take 5 ml of the sample stock solution of 7.1 (6) with a whole pipette, transfer it immediately in a 100 ml volumetric flask, add water to bring it up to the marked line, mix well, take 20 ml of this diluted sample solution with a whole pipette and transfer it to an Erlenmeyer flask (100 ml).

(2) Add 2 or 3 drops of phenolphthalein indicator (1 % ethanol solution), titrate little by little with 0.05 N (mol/l) hydrochloric acid standard solution, and take it as the end point when, by the last drop, the faint red solution turns colorless.

(3) Then, take 20 ml of the diluted sample solution again, titrate it carefully referring to the result of the first titration and take the result obtained here as the formal measured value.

7.2.2 Calculation   The decrease in alkali concentration shall be calculated from the following formula:

$$Rc = \frac{20 \times 0.05 \times F}{V_1} (V_3 - V_2) \times 1000$$

where, Rc :   decrease in alkali concentration (mmol/l)

V_1 :   aliquot from diluted sample solution in 7.2.1 (1) (ml)

V_2 :   volume of 0.05 N hydrochloric acid standard solution required for titration of the diluted sample solution (ml)

V_3 : volume of 0.05 N (mol/l) hydrochloric acid standard solution required for titration of the diluted sample solution in the blank test (ml)

F : factor of 0.05 N (mol/l) hydrochloric acid standard solution

7.3 **Methods of determining dissolved amount of silica**   Measurement of the dissolved amount of silica shall be made by one of the following methods:

(1)   Gravimetric method

(2)   Atomic absorption photometric method

(3)   Absorption photometric method

7.3.1   **Gravimetric method**

(1)   **Procedure**   Take n aliquot of the stock solution, add hydrochloric acid, evaporate to dryness, and treat it with perchloric acid. Ignite the precipitate and then treat it with hydrogen fluoride. The detailed procedure shall be as follows:

   (a)   Take 5 ml of the stock solution of 7.1 (6) with a whole pipette and transfer it to a platinum plate (75 ml) or a beaker (100 ml).

   (b)   Add 5 ml of hydrochloric acid (1 + 1), mix and then evaporate it to dryness on the water bath in a draft chamber.

   (c)   After evaporating to dryness, add 8 ml of perchloric acid (60 % or 70 %), heat on a sand bath, evaporate taking care not to let the content scatter about and, when thick white fume of perchloric acid begins to rise, cover with a watch glass and continue heating for 10 min with the bottom of the vessel a little sunk in the sand.

   (d)   Take down the platinum plate or beaker from the sand bath, cool, take off the watch glass after washing with water, add 5 ml of hydrochloric acid (1 + 1) and about 20 ml of warm water, stir it with a glass rod, and after crushing lumps of jelly thoroughly, filter with filter paper (Class 5B, 110 mm in diameter specified in JIS P 3801) and wash ten times with warm water.

   (e)   Put the precipitate in a platinum crucible (30 ml), drip 2 or 3 drops of sulfuric acid (1 + 10) on the filter paper, dry, heat slowly without producing flame to carbonize and then incinerate it. Then ignite it in an electric furnace controlled at 1000 ± 50°C for one hour, cool in a desiccator, and weigh the mass.

   Moisten the inside of the platinum crucible with a small amount of water, add 2 or 3 drops of sulfuric acid (1 + 1) and 10 ml of hydrofluoric acid (about 47 %), and heat gently on the sand bath in a draft chamber to effect a hydrofluoric acid treatment and further heat to perform a white fume treatment of sulfuric acid. Then, raise the temperature slowly, ignite at 1000 ± 50°C for 5 min, cool in a desiccator, and weigh the mass.

(2) <u>Calculation</u>   The dissolved amount of silica shall be calculated from the following formula:

$$Sc = 3330 \times W$$

where, Sc : dissolved silicon dioxide (mmol/l)

   W : mass of silicon dioxide in 5 ml of the sample
         stock solution calibrated by blank test (g)

7.3.2   <u>Atomic absorption photometric method</u>   The atomic absorption
photometric method is a quantitative analytical method to obtain the silica
content by atomizing the diluted sample solution in the high temperature
acetylene-dinitrogen oxide flame and measuring the absorbance at a wavelength
of 251.6 nm. The preparation, procedure and calculation shall be as follows:

(1) <u>Preparation of standard solution</u>

   (a)   Take the accurate aliquots of 0 ml, 10 ml, 20 ml, 30 ml and 40 ml
         from the silica standard stock solution (SiO$_2$ 10 mmol/l) of 5.2 (11)
         and put each of them in a 100 ml volumetric flask, add water up to
         the marked line (0 mmol/l, 1.0 mol/l, 2.0 mmol/l, 3.0 mmol/l and
         4.0 mmol/l as SiO$_2$), shake well and transfer to a polyethylene vessel.

   (b)   When the silica standard solution (Si 1000 ppm) on the market is
         used, take the accurate aliquots of 0 ml, 1.0 ml, 2.0 ml, 4.0 ml,
         6.0 ml, 8.0 ml and 10.0 ml from this standard solution and put each
         of them in a 100 ml volumetric flask, add water up to the marked
         line (0 mg/l, 10 mg/l, 20 mg/l, 40 mg/l, 60 mg/l, 80 mg/l and 100 mg/l
         as Si), shake well and transfer to a polyethylene vessel.

(2) <u>Plotting of working curve</u>

   (a)   Light the hollow cathode lamp for silicon of atomic absorption
         photometer, and set the lamp to the optimum conditions in order to
         stabilize the brightness. After igniting the burner using acetylene
         and air, change over to the high temperature flame of acetylene-
         dinitrogen oxide.

   (b)   Set the conditions optimum for acetylene-dinitrogen oxide flow rate,
         the burner head position, etc. by spraying the most concentrated
         silica standard solution.

   (c)   Then measure the absorbance of each standard solution, and plot a
         curve relative to the silica concentration, and use it as working
         curve.

(3) <u>Procedure</u>   Measure the absorbance of the diluted sample solution
   prepared in accordance with 7.2.1 (1) under the same condition as in
   plotting the working curve. When the absorbance exceeds that of the most
   concentrated silica standard solution, first adjust the concentration of the
   diluted sample solution adequately and exactly (dilution ratio n) before
   resuming the measurement.

(4) Calculation   The dissolved amount of silica shall be calculated from the formula (1) when the silica standard stock solution (SiO_2 10 mmol/l) is used, and from the formula (2) when the market silica standard solution (Si 1000 ppm) is used.

$$Sc = 20 \times n \times C \quad \text{....................(1)}$$

$$Sc = 20 \times n \times A \times \frac{1}{28.09} \quad \text{....................(2)}$$

where, Sc : dissolved amount of silica (mmol/l)

n : dilution ratio

C : silica content obtained from the working curve (SiO_2 mmol/l)

A : silica content obtained from the working curve (Si mg/l)

7.3.3   Absorption photometric method   After the reaction between silica in the diluted sample solution and the ammonium molybdate has occurred, add oxalic acid, measure the absorbance at the wavelength in the vicinity of 410 nm and determine amount of silica.

(1)   Plotting of working curve

(a)   Take the accurate aliquots of 0 ml, 1.0 ml, 2.0 ml, 3.0 ml and 4.0 ml from the silica standard sock solution (SiO_2 10 mmol/l) of 5.2 (11), put each of them in 100 ml volumetric flask, and add water to make about 50 ml.

(b)   Add 2 ml of ammonium molybdate solution (10 %) and 1 ml of hydrochloric acid (1 + 1) and shake. After leaving still for 15 min, add exactly 1.5 ml of oxalic acid solution (10 %), and add water up to the marked line and agitate (0 mmol/l, 0.1 mmol/l, 0.2 mmol/l, 0.3 mmol/l and 0.4 mmol/l as SiO_2).

(c)   When a silica standard solution (Si 1000 ppm) on the market is used, take exactly 10 ml of the silica standard solution and put in a 100 ml volumetric flask, add water up to the marked line and agitate. From this solution, take the exact aliquots of 0 ml, 2.0 ml, 4.0 ml, 6.0 ml and 10.0 ml and put each of them in a 100 ml volumetric flask separately, and add water to make up the volume to about 50 ml.

(d)   Then, treat the solutions in the same manner as in (b) (0.0 mg/l, 2.0 mg/l, 4.0 mg/l, 6.0 mg/l and 10.0 mg/l as Si).

(e)   Leave still each standard solution for 5 min ± 10 s, measure the absorbance at the wavelength in the vicinity of 410 nm using water as the contrast solution, and plot a curve relative to the silica concentration to take as working curve.

(2)   Procedure

(a)   Take 10 ml (V) of the diluted sample solution prepared in accordance with 7.2.1 (1) with a whole pipette and transfer it into a 100 ml volumetric flask.

    (b)   After adding water to make up the volume to about 50 ml, treat the solution in the same manner as in (1) (b).

    (c)   After leaving still for 5 min ± 10 s, measure the absorbance in the same condition as in plotting the working curve. When the absorbance falls outside the range from 0.1 to 0.6, repeat the measurement after adjusting the concentration of the sample solution adequately.

(3)   <u>Calculation</u>   The dissolved amount of silica shall be calculated from formula (3) when the silica standard stock solution (SiO₂ 10 mmol/l) is used, and from formula (4) when the market silica standard solution (Si 1000 ppm) is used.

$$Sc = 20 \times n \times C \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \quad (3)$$

$$Sc = 20 \times n \times A \times \frac{1}{28.09} \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (4)$$

where, Sc : dissolved amount of silica (mmol/l)

             n : dilution ratio

             C : silica content obtained from the working curve (SiO₂ mmol/l)

             A : silica content obtained from the working curve (Si mg/l)

8. Method of summarizing test results

8.1   <u>Entry in data sheets</u>   Each determined value shall be expressed in mmol/l and entered in data sheet after rounded off to an integer. The form of data sheet shall be as shown in Annex 7 Table 1.

8.2   <u>Precision tolerances</u>   Individual values of three determinations on the decrease in alkali concentration and the dissolved amount of silica shall not differ from respective mean values by more than 10 %. However, in the case where both values are not more than 100 mmol/l, the difference shall be within 10 mmol/l.

If the test results exceed these ranges, a retest shall be performed.

9. Evaluation of potential alkali-silica reactivity of aggregates

    The potential alkali-silica reactivity of aggregates shall be judged harmful when the dissolved amount of silica (Sc) is more than the decrease in alkali concentration (Rc) in the case where the dissolved amount of silica (Sc) is 10 mmol/l or over and the decrease in alkali concentration (Rc) is under 700 mmol/l, and shall be judged harmless in the cases where the dissolved amount of silica (Sc) does not exceed the decrease in alkali concentration (Rc).

| 1. Date of test: | | | | | | | | | | Factor of 1 N (mol/l) — NaOH | | | | | | | |
| 2. Person in charge: Department Name | | | | | | | | | | Factor of 0.05N (mol/l) — HCl | | | | | | | |

Name of aggregates	Number of tests repeated	Mass of sample (g)	Reaction time (hr)	Decrease in alkali concentration (Rc) (mmol/l)				Dissolved amount of silica (Sc) (mmol/l)										Evaluation
								Gravimetric method			Atomic absorption photometric method			Absorption photometric method				
				V_1 (ml)	V_2 (ml)	Rc	Mean	W (g)	Sc	Mean	C (mmol/l) or A (mg/l)	Sc	Mean	V (ml)	C (mmol/l) or A (mg/l)	Sc	Mean	
	1																	
	2																	
	3																	
	1																	
	2																	
	3																	
	1																	
	2																	
	3																	

Annex 8. Test method for potential alkali-silica reactivity of aggregates (mortar bar method)

1. **Scope**   This Annex specifies the test method for evaluation the potential alkali-silica reactivity of aggregates by measuring the length variation of mortar bars.

2. **Sample**   The sample shall be unused aggregates and aggregates in fresh concrete and about 40 kg of representative samples shall be taken each from the coarse and fine aggregates (¹).

> Note (¹) When the test is made immediately succeeding the chemical method, the same sample shall be used as a specimen.

3. **Test apparatus**

3.1 **Balance**   The balance to serve for screening the aggregates shall be of an accuracy more than 0.1 % of the mass of aggregates. The balance for weighing materials for preparation of mortar shall be of 2 kg of weighing capacity with reciprocal sensibility to the nearest 0.1 g.

3.2 **Formwork**   The formwork shall be of the triple type 40 mm × 40 mm × 160 mm in dimension specified in JIS R 5201, and fitted with a hole on either side to be used for embedding and fixing plug gauges for measuring the length variation.

3.3 **Measuring apparatus for length variation**   Measurement of length variation shall be made in accordance with the dial gauge method prescribed in JIS A 1129.

The dial gauge of the minimum scale (accuracy) of 0.001 mm prescribed in JIS B 7503 shall be used. The gauge plugs shall be of a metal which will not rust while testing.

3.4 **Apparatus for preparing mortar**   The apparatus to be used for mixing, forming and compacting mortar shall be those specified in 10.1 (1) (mixer) and in 10.1 (2) (mould and tamping rod for moulding mortar specimen) of 10.1 (testing appliances) in JIS R 5201, respectively.

3.5 **Sieve**   As the sieves for adjusting the grain sizes of sand, those of 4.75 mm, 2.36 mm, 1.18 mm, 600 μm, 300 μm, and 150 μm in nominal sizes, specified in JIS Z 8801, shall be used.

3.6 **Storage containers**   The storage containers for the specimens shall be so constructed as to be closed tightly with an airtight cover and to be free from loss of humidity.

3.7 **Refiner**   The refiners which produce fine aggregates from coarse aggregates shall be a rod mill, a jaw crusher, a disk-type refiner, a roll-type refiner, etc.

4. Temperature and humidity

4.1 Molding room and measuring room The mortar molding room and the measuring room shall be kept at temperature 20 ± 3°C.

4.2 Storage container The temperature and relative humidity of the inside of storage container shall be kept at 40 ± 2°C and 95 % or over, respectively.

5. Materials

5.1 Preparation of aggregates and adjustment of particle size When the aggregates to be used are coarse aggregates, wash beforehand and pulverize with a crusher or the like to obtain fine aggregates. Adjust the fine aggregates under air-dry condition (absolute or surface dry condition is acceptable) to the grading shown in Annex 8 Table 1.

Annex 8 Table 1. Grading distribution of fine aggregates

Nominal dimension of sieve		Mass
Passing through	Retained on	Percentage (%)
4.75 mm	2.36 mm	10
2.36 mm	1.18 mm	25
1.18 mm	600 μm	25
600 μm	300 μm	25
300 μm	150 μm	15

5.2 Cement The ordinary portland cement in which the total alkali is 0.65 ± 0.05 % and the ratio of Na_2O (%) to K_2O (%) is in the range of 1 : 2 ± 0.5 specified in JIS R 5210 shall be used, and its content of Na_2O and K_2O shall be obtained beforehand in accordance with JIS R 5202.

5.3 Sodium hydroxide The reagent of special grade specified in JIS K 8576 shall be used as sodium hydroxide solution.

Further, 1 N (mol/l) sodium hydroxide solution available on the market may be used instead.

5.4 Water Water conforming to 4. (water from public water supply) of Annex 9, shall be used for mixing.

6. Preparation of specimens (mortar bars)

6.1 Number of specimens The number of specimens used for one test shall, as a rule, be three.

Further, three specimens shall be prepared from one batch.

6.2 <u>Mixing proportion of mortar</u>   The mixing proportion of mortar shall be 1 cement, 0.5 water, and 2.25 sand in mass ratio.

The amount of cement, sand and water for one mixing batch shall, as a standard, be as follows:

Water + NaOH solution	:	300 ml
Cement	:	600 g
Sand (surface dried)	:	1350 g

The amount of NaOH solution shall be determined by calculation so as to make the total alkali amount in the cement 1.2 ± 0.05 %, as expressed by Na_2Oeq.

6.3 <u>Measuring of materials</u>   The materials to be measured by mass shall be weighed to obtain four significant figures. In the case of sand not surface-dried, the water content (water absorption) shall be measured preliminarily for the correction of water amount at the time of measuring it in order to keep the water-cement ratio unchanged.

6.4 <u>Mixing method</u>   The mixing of mortar shall, as a rule, be as prescribed below:

The mixer prescribed in 10.1(1) of JIS R 5201 shall be used. Fix the mixing drum and paddle to the mixing position and pour the specified quantity of cement and sand into the vessel. Then start the mixer and mix for 30 s while rotating the paddle. Then, stop the mixer and put the specified amount of water. After restarting and running for 30 s, stop the mixer for 20 s. During the suspension, scrape off the mortar adhering to the mixing drum and paddle with a spoon. In addition, mix the mortar at the bottom of the mixing drum 2 or 3 times in a spooning-up motion. With the suspension over, start again the mixer and mix for 120 s.

6.5 <u>Molding</u>   Immediately pour the mortar in the formwork in two layers up to one half of the height of formwork and tamp the mortar with a tamping rod about 15 times over the whole surface of each layer with the tip of the rod sinking about 5 mm into the mortar each time. In this case, care shall be taken so that the mortar is distributed sufficiently around the gauge plug, especially. Then, pour the mortar up to the upper edge of the formwork, tamp it with the tamping rod in the same manner as before and heap the residual mortar about 5 mm in height above the edge. After the placing process, put the formwork in a wet box and cover with a wet cloth or the like so as to keep the mortar surface untouched and to minimize the drying of the mortar. About 5 h after the placing process, shave off the extra-placed part to make the upper surface smooth, taking care not to injure the specimen.

7. <u>Initial curing</u>   For 24 ± 2 h after placing, put the formwork containing the mortar in the wet box and cover it with a wet cloth or the like to keep the mortar surface untouched and to minimize the drying of the mortar.

8. <u>Removal of formwork</u> After completion of the initial curing, the formwork shall be removed. At the time, clearly mark the mortar with the specimen number and symbols indicating top or bottom, or direction of the specimen when tested, taking care not to lessen the moisture content. The period from the placement to the removal shall be 24 ± 2 h.

9. <u>Method of measuring base length</u> Immediately after marking the number on the specimen removed from the formwork, the base length shall be measured with care not to dry the specimen.

10. <u>Storage and measurement</u> The specimens shall be stored in a sealed container kept at 40 ± 2°C and at not lower than 95 % RH. As a means of keeping the relative humidity at not lower than 95 %, it should be preferable to cover the surface of the specimen with blotting paper containing water to an extent not to flow out. In this case, the sealed container may be replaced by a vinyl bag.

When not covering the surface of the specimen with blotting paper, put temperature-controlled water at the bottom face of the container and erect the specimens one by one upright on a stand or the like so as not to contact the water.

When the specimen has reached the specified material age, take it out of the storage room or the storage box together with the container, and after keeping at 20 ± 3°C for at least 16 h, open the container and take measurement for that age. During the measurement, keep the specimen from drying.

After the measurement, immediately restore the specimen to the conditions of 40 ± 2°C and 95% RH or over.

All the specimens which are to go into the same container subsequent to the initial measurement of their lengths after the lapse of 24 ± 2 h shall be prepared on the same day and put in the same container at the same time so that they can all be subjected to measurement simultaneously.

After the measurement, the specimens shall be put again in the container with their positions of top or bottom reversed from those during the previous period.

11. <u>Measuring method</u>

11.1 <u>Measurement of change in length</u> The measurement shall be made in accordance with the dial gauge method of JIS A 1129. The length measuring frame shall be kept in the same conditions (perpendicular or at fixed degrees to the perpendicular) as in the measurement of the perpendicularity and temperature. Contact the contact point of the measuring frame with one of the two plugs of the reference rod, make the tip of the dial gauge move in concert with the travel of reference rod, push out the spindle slowly and contact it with the other plug of the standard scale, and read the dial gauge to the nearest $\frac{1}{1000}$ mm. Draw the spindle in, repeat the above operations, and from the readings when the values have stabilized, obtain the mean value to take it as sXi.

Carry out the above operations on specimens and obtain Xi.

The specimens shall always be placed with the same end up and with the same face in front. The relative positions of the gauge and the specimen shall always be kept the same.

The measuring instruments and standard scale shall be kept at the temperature specified for the respective tests for 3 h till the start of the measurement.

11.2 <u>Observation of appearance</u>   Along with the measuring of the change of length, observation shall be made of the change of warping and popout and the like of the specimen, and fissure, bleading products such as the gel of water glass and soil on the surface.

12. <u>Calculation of expansion coefficient</u>   The difference between the initial length and the length at each material age shall be divided by the effective gauge length, and calculated to the nearest 0.001 %, and the result shall be recorded as the expansion coefficient of the specimen during this period.

The expansion coefficient shall be calculated from the following formula:

$$\text{Expansion coefficient (\%)} = \frac{(Xi - sXi) - (Xini - sXini)}{L} \times 100$$

where, Xi : reading of dial gauge on the specimen at material age i

sXi : reading of dial gauge of standard scale at material age i

$Xini$: reading of dial gauge at the time of removal of the specimen from formwork

$sXini$: reading of dial gauge of standard scale with which measurement has been made at the same time

L : effective gauge length (^{2}) (distance between inside end surfaces of the gauge plug)

(The units for Xi, sXi, $Xini$, $sXini$, and L shall be the same.)

Note (^{2}) Pay heed to the fact that the effective gauge lengths may differ according to the individual gauge plugs.

13. <u>Material ages for measurements</u>   The material ages at which measurements are to be made shall be indicated below:

At the time of removal of formwork, 2 weeks, 4 weeks, 8 weeks, 3 months and 6 months.

14. <u>Evaluation</u>   When the mean expansion coefficient of three specimens after six months turns out under 0.100 %, it shall be judged harmless, and when 0.100 % or over not harmless.

Remarks: Expansion of 0.050 % or over after 3 months may be judged not harmless. However, when the result is under 0.050 % after 3 months, judgment shall be deferred until after the test has been continued for additional 6 months.

15. <u>Precision</u>   When the absolute difference between the mean expansion coefficient of all the specimens molded from the same batch and those of individual specimens is within 0.010 %, the precision may be considered satisfactory. However, in the case where the mean expansion coefficient exceeds 0.050 %, the precision may be deemed satisfactory provided that the relative difference between the expansion coefficient of the individual specimens and the mean expansion coefficient does not exceed ± 20 %. When all three specimens show expansion of 0.100 % or over, judgment shall be "not harmless" regardless of the precision.

Remarks: When the condition of precision does not conform to any of the above conditions, the judgment may be made from the average value of the two specimens excluding the one which shows the smallest expansion.

16.   <u>Report</u>   In the report, the following information shall be stated:

(1)   Origin and type of aggregates

(2)   Total alkali in cement [potassium oxide (K_2O), sodium oxide (Na_2O) and total alkali]

(3)   Expansion coefficients for individual measuring ages of specimens and their mean values

(4)   Other important facts observed on specimens during and after the test and the like

Annex 9. Water to serve for mixing ready-mixed concrete

1. **Scope** This Annex specifies water to serve for mixing the ready-mixed concrete (hereafter referred to as "water").

2. **Classification** The water shall be classified into water from public water supply, water other than water from public water supply and recycled water.

3. **Definitions** For the purpose of this Annex, the following definitions apply:

(1) **water other than water from public water supply** Water taken as river water, lake water, well water, underground water and the like which are not particularly subjected to the treatment as water for public water supply or industrial water, except for the recycled water.

(2) **recycled water** Generic term for sludge water and supernatant water obtained by treating the wastewater used for washing the ready-mixed concrete adhering to the transport vehicle, mixer, hopper and the like of the plant and the returned concrete (hereafter referred to as "wastewater of washing concrete"), as distinct from other forms of wastewater generated by washing-out operations in the plant of ready-mixed concrete.

(3) **sludge water** Suspension water which remains after coarse and fine aggregates are separated and recovered from the washing wastewater of ready-mixed concrete.

(4) **supernatant water** Water which is obtained from the sludge water by removing the sludge solid content by precipitation or other means.

(5) **sludge** Substance produced from the sludge water through concentration and loss of fluidity.

(6) **sludge solid content** Substance obtained by drying the sludge at 105°C to 110°C.

(7) **sludge solid content ratio** the ratio in percentage of the mass of sludge solid content to the unit mass of cement in the proportion of ready-mixed concrete.

4. **Water from public water supply** The water from public water supply may be used without particular tests.

5. **Water other than that from public water supply** Water other than that from public water supply shall be tested in terms of quality in accordance with the test method of 8.1 and the results shall comply with the criteria given in Annex 9 Table 1.

Annex 9 Table 1. Quality of water other than that from public water supply

Item	Quality
Quantity of suspended matter	2 g/l or under
Quantity of soluble residue on evaporation	1 g/l or under
Chloride ion (Cl-) content	200 ppm or under
Difference in solidification time of cement	30 min or under at start, 60 min or under at end
Ratio of compressive strength of mortar	90 % or over at material age of 7 days and material age of 28 days

6. Recycled water

6.1 Quality   The quality of recycled water shall comply with the criteria specified in Annex 9 Table 2 when it is tested in accordance with the test method of 8.2. Its raw water, however, shall comply with the specification of 4. or 5.

Annex 9 Table 2. Quality of recycled water

Item	Quality
Chloride ion (Cl-) content	200 ppm or under
Difference in solidification time of cement	30 min or under at start, 60 min or under at end
Ratio of compressive strength of mortar	90 % or over at material age of 7 days and material age of 28 days

6.2 Limit of sludge solid content ratio   when the sludge water is used, its sludge solid content ratio shall not exceed 3 %.

> Informative reference: In the proportion of ready-mixed concrete, the sludge solid content in the sludge water shall not be included in the mass of water.

7. Case where waters are mixed for use   When the mixed water consists of two or more kinds of water are used, each component water shall comply with the requirement of 4., 5. or 6., respectively.

8. Test method for water

8.1 Water other than that from public water supply

8.1.1 Test items   The test items shall be as follows:

(1)   Suspended matter content

(2)   Content of soluble residue on evaporation

(3)   Chloride ion (Cl⁻) content

(4)   Difference in solidification times of cement

(5)   Ratio of compressive strength of mortar

8.1.2   **Test appliances**   The test appliance used for (1) and (2) of 8.1.1 shall be as follows:

(1)   The container for the sample shall be a hard glass bottle with ground-in stopper or a polyethylene bottle with a cover. A bottle thoroughly cleaned shall be used.

(2)   The appliances used for analysis shall be two volumetric flasks (200 ml and 100 ml, one each), a filter made of glass (Büchner-funnel type 3G2), a porcelain evaporating dish (10 cm to 20 cm in diameter), a watch glass (10 cm to 20 cm in diameter), a beaker (500 ml), a filter paper (Class 6 or glass-fiber reinforced filter paper specified in JIS P 3801), a desiccator (one which can accommodate a filter made of glass and a porcelain evaporating dish), a precision chemical balance and an electric thermostatic drier.

8.1.3   **Sample**   The sample shall be as follows:

(1)   Fill the sample bottle with the water to be tested, tightly seal the bottle with a clean stopper leaving no air space above the sample surface, and carry out the test within 7 days after the sampling.

(2)   The amount of sample taken for one test shall be approximately 4 l.

(3)   When well water is to be sampled, the water after some quantity of water has been pumped up shall be sampled as the test water. In sampling from a river, a lake, a lagoon or reservoir, samples shall be taken several times a day and equal amounts of the samples shall be mixed to obtain a representative sample.

8.1.4   **Test for content of suspended matters**   The test for the content of suspended matters shall be as follows:

(1)   **Procedure**

    (a)   Lay a filter paper on the bottom of a glass filter and dry it at a temperature of 105°C to 110°C. Cool to ordinary temperature in a desiccator, and weigh the mass (W_1) of the glass filter and filter paper to the nearest 0.01 g.

    (b)   Measure 200 ml of test water with a volumetric flask, filtrate the whole water, dry the residue together with the filter at a temperature of 105°C to 110°C, cool to ordinary temperature in a desiccator, and weigh the mass (W_2) of the glass filter, residue on the filter paper and the filter paper to the nearest 0.01 g. The filtrate shall be used in 8.1.5.

(2) **Calculation** Calculate the content (S_d) of suspended matters from the following formula and round off the results to the first decimal place in accordance with JIS Z 8401.

$$S_d = (W_2 - W_1) \times 5$$

where, S_d : content of suspended matters (g/l)

W_1 : mass of glass filter and filter paper (g)

W_2 : mass of glass filter, residue on the filter paper and filter paper (g)

8.1.5 <u>Test for content of soluble residue on evaporation</u> The test for the content of the soluble residue on evaporation shall be as follows:

(1) <u>Procedure</u>

(a) Dry a well-cleaned porcelain evaporating dish at 105°C to 110°C, cool to ordinary temperature in a desiccator, and then weigh its mass (W_3) to the nearest 0.01 g.

(b) Take 100 ml of the filtrate free from suspended matters in 8.1.4 (1) (b) to a volumetric flask and transfer it to the porcelain evaporating dish.

(c) Cover the evaporating dish with a watch glass leaving a small gap, evaporate to dryness by heating on a water bath, and dry it at a temperature of 105°C to 110°C. After cooling the dried evaporation residue to ordinary temperature, weigh its mass (W_4) to the nearest 0.01 g.

(2) **Calculation** calculate the content of the soluble residue on evaporation (Ss) from the following formula and round off the result to the first decimal place in accordance with JIS Z 8401.

$$S_s = (W_4 - W_3) \times 10$$

where, S_s : content of soluble residue on evaporation (g/l)

W_3 : dried mass of evaporating dish (g)

W_4 : total mass of residue evaporated to dryness and evaporating dish (g)

8.1.6 <u>Test for chloride ion (Cl⁻) content</u> The test shall be performed in accordance with the test method specified in Annex 5.

8.1.7 <u>Test for difference in cement solidification time</u> The test for difference in cement solidification time shall be as follows:

(1) <u>Test method</u> The test shall be performed using the test water and the reference water ([1]) in accordance with 8. (setting time test) of JIS R 5201. However, the cement-water ratio of mortar using the reference water and that using water other than the water from public water supply shall be identical.

Note (¹) The reference water means distilled water, water purified by ion-exchange resin or water from public water supply.

(2) Calculation   Express the start and end times in minute, and calculate the difference in the start time and the difference in the end time.

$$Ti = |Tio - Tis|$$

$$Tf = |Tfo - Tfs|$$

where, Ti : difference in start time (min)

Tio : start time when reference water is used (min)

Tis : start time when water other than from public water supply is used (min)

Tf : difference in end time (min)

Tfo : end time when reference water is used (min)

Tfs : end time when water other than from public water supply is used (min)

8.1.8 Test for compressive strength ratio of mortar   The test for compressive strength ratio of mortar shall be performed either by the method (method A) in accordance with 10. (strength test) of JIS R 5201 or the method (method B) using a columnar specimen 5 cm in diameter and 10 cm in height. The procedure according to the method B will be described below. Note that the calculation in the case of the method A shall be as shown in (5).

(1) Test apparatus and appliances

  (a) The balance shall be 2000 g or over in weighing capacity and be capable of weighing to the nearest 0.5 g.

  (b) The mixer shall be as follows: an electric mixer with the mixing drum of a nominal capacity of 4.7 l or over and having a paddle which makes a circular motion rotating on its own axis and at the same time revolving in the opposite direction. The number of revolutions of the paddle shall be 140 ± 5 rpm for rotation and approximately 62 rpm for revolution in the case of a low speed, and 285 ± 10 rpm for rotation and approximately 125 rpm for revolution in the case of high speed.

  (c) The formwork shall be a metal cylinder 5 cm in inside diameter and 10 cm in height.

  (d) The tamping bar shall be a steel bar 9 mm in diameter with an obtusely pointed end.

(2) Test conditions   The temperature in test room from the time of molding to the time of immersion shall be 10°C to 25°C. However, the temperature change from the start of molding to the completion of molding shall be within 4°C.

(3) Materials used in test

(a) The cement shall, as a rule, be the ordinary portland cement used in the plant.

(b) The sand to serve shall be the sand usually used in the plant and subsequently changed into a saturated surface-dry condition. To effect a saturated surface-dry condition of sand, (3) of 3. (sample) of JIS A 1109 shall be conformed to.

(4) Procedure

(a) Set the mixing drum and paddles to the mixer, pour 400 g of test water in the mixing drum and 800 g of cement, and then mix for 40 s at low speed. Meanwhile, slowly put the sand in the saturated surface-dry condition. The amount of sand to be put shall ensure the predetermined flow of mortar (^{3}) to be 190 ± 5. Then, stop for 20 s, and in the meanwhile scrape off the mortar adhering to the mixing drum and paddles with a spoon. Thereafter, mix for 2 min at high speed to prepare the mortar. Also in the case where the reference water is used in place of the test water, mix in the same manner as above and prepare two batches of mortar.

Note (^{3}) The flow test of mortar shall be performed in accordance with 10.7 (measuring method of flow value) of JIS R 5201.

Informative reference: The amount of the sand to be put in the mortar shall be in the range from 2000 g to 2500 g in the case of the river sand.

(b) Fill the formwork with this mortar in two layers and tamp each layer 25 times with a tamping bar. After tamping with the tamping bar, slightly tap the formwork so as to level off the holes produced by tamping. In this way, prepare four specimens from each batch of mortar.

(c) Four h after the mortar is poured into the formwork, the mortar is subjected to a capping treatment. Remove the formwork 24 h later and cure the specimen till the day of test.

The capping and curing shall be performed in accordance with 4.4 (finishing of upper surface of the specimens) and 7. (removing of formwork and curing) of JIS A 1132.

(d) Seven days and 28 days after the preparation of the specimens, perform a compressive strength test on four specimens of each material age.

The compressive strength test shall be performed in accordance with JIS A 1108.

(5) Calculation   Calculate the ratio (R) of compressive strength of the mortar from the following formula:

$$R = \frac{\sigma_{cr}}{\sigma_{co}} \times 100$$

where, R :   ratio of compressive strength of mortar (%)

            σ_{co} :   compressive strength of mortar prepared using reference water at material age of 7 days or 28 days (kgf/cm^2) {N/cm^2}

            σ_{cr} :   compressive strength of mortar prepared using water other than from public water supply at material age of 7 days or 28 days (kgf/cm^2) {N/cm^2}

8.1.9   <u>Report</u>   The report of test results on the water other than from public water supply shall include the following items:

(1)   Division of river water, lake water, well water or underground water

(2)   Suspended matter content

(3)   Content of soluble residue on evaporation

(4)   Chloride ion (Cl⁻) content

(5)   Difference in solidification time of cement

       (a)   Start and end times in the case of the reference water

       (b)   Start and end times in the case of the water other than from public water supply

       (c)   Differences between the start times and end times in the cases of (a) and (b)

(6)   Ratio of compressive strength of mortar

       (a)   Test method (method A or B referred to in 8.1.8)

       (b)   Compressive strength in the case of the reference water (at material ages of 7 days and 28 days)

       (c)   Compressive strength in the case of the water other than from public water supply (at material ages of 7 days and 28 days)

       (d)   Ratio of compressive strength of the mortar prepared using the reference water to that of the mortar prepared using the water other than from public water supply

8.2   <u>Recycled water</u>

8.2.1   <u>Test items</u>   The test items shall be as follows:

(1)   Chloride ion (Cl⁻) content

(2)   Difference in solidification time of cement

(3)   Ratio of compressive strength of mortar

8.2.2   <u>Samples</u>   The samples shall be as follows:

(1)   The representative sample of the sludge water shall be taken from a sludge water storage tank in the ready-mixed concrete plant, and shall be tested without delay.

(2)   The supernatant water shall be put in a test bottle at a supernatant water storage tank in the ready-mixed concrete plant, and the test bottle shall be tightly sealed with a clean stopper leaving no space of air above the water. The test shall be conducted within 7 days after sampling.

8.2.3   Test for chloride ion (Cl⁻) content   The test for chloride ion (Cl⁻) content shall be in accordance with the test method specified in Annex 5.

8.2.4   Test for difference in solidification time of cement   The test for the difference in solidification time of cement shall be performed as follows:

(1)   Test method   The test shall be performed in accordance with the test method of 8.1.7. However, the sludge water to serve shall be that of which the concentration is 4.5 % (^{3}) as determined by the test method of 8.2.6. The supernatant water shall be used as it is.

Further, the cement water ratio in the case of the reference water shall be the same as that in the case of the recycled water.

Note (^{3})   The solid content in this sludge water shall not be included in the amount of the water.

(2)   Calculation   calculate the difference in start time and the difference in end time, each expressed in min, from the following formula:

$$Ti' = |Tio - Tis'|$$

$$Tf' = |Tfo - Tfs'|$$

where, Ti' :   difference in start time (min)

   Tio :   start time in the case of reference water (min)

   Tis' :   start time in the case of recycled water (min)

   Tf' :   difference in end time (min)

   Tfo :   end time in the case of reference water (min)

   Tfs' :   end time in the case of recycled water (min)

8.2.5   Test for ratio of compressive strength of mortar   The test for the ratio of the compressive strength of mortar shall be as follows:

(1)   Test method   The test shall be performed in accordance with the test method of 8.1.8. However, in the case of method A, the water to serve shall be 338 g of the reference water, 354 g (^{4}) of sludge water of the concentration of 4.5 % as determined by the test method of 8.2.6, and 338 g of the supernatant water.

In the case of method B, 400 g of the reference water, 419 g of sludge water of the concentration of 4.5 % as determined by the test method of 8.2.6 and 400 g of the supernatant water.

Note (^{4})   The mass of sludge water in this case contains the sludge solid content.

(2)   <u>Calculation</u>   Calculate the ratio (R') of the compressive strength of mortar from the following formula:

$$R' = \frac{\sigma_{cr}{}'}{\sigma_{co}} \times 100$$

where, R' :   ratio of compressive strength of mortar (%)

σ_{co} :   compressive strength at material ages of 7 days or 28 days of mortar prepared using reference water (kgf/cm^2) [N/cm^2]

$\sigma_{cr}{}'$:   compressive strength at material ages of 7 days or 28 days of mortar prepared using recycled water (kgf/cm^2) [N/cm^2]

3.2.6   <u>Test for concentration of sludge water</u>   The test for the concentration of the sludge water shall be as follows:

(1)   <u>Test appliances</u>

    (a)   The balance shall be 1000 g or over in weighing capacity and be capable of weighing to the nearest 0.1 g.

    (b)   The vat for drying shall be sufficiently large to accommodate approximately 500 ml of the sludge water.

    (c)   A 500 ml volumetric flask

    (d)   A 500 ml beaker

(2)   <u>Sample</u>   Take approximately 5 l of the representative sludge water, and use this as the sample.

(3)   <u>Procedure</u>

    (a)   Take approximately 500 ml of sample in the drying vat while stirring the sample well, and weigh its mass (W) to the nearest 0.1 g.

    (b)   Put the vat in a drier and dry at 105°C to 110°C to constant mass. After allowing to cool to room temperature, weigh the mass (S) to the nearest 0.1 g.

(4)   <u>Calculation</u>   Calculate the concentration (Cs) of the sludge water from the following formula, and round off the obtained value to the first decimal place in accordance with JIS Z 8401.

$$Cs = \frac{W}{S} \times 100 - 0.2$$

where, Cs :   concentration of sludge water (%)

W :   mass of sludge water (g)

S :   mass of sludge after dried (g)

Informative reference:
> According to the report of the Recycled Water Committee of Japan Concrete Institute, the country-wide mean value of the content of soluble components in the supernatant water is 0.2 %. Accordingly, subtract this value from the calculated result, and the value obtained will be approximately the same as that obtained by the filtration method.

8.2.7 <u>Report</u>   In the test result report of the recycled water the following items shall be entered:

(1)   Sludge water or supernatant water

(2)   Chloride ion (Cl⁻) content

(3)   Difference in solidification time of cement

    (a)   Start and end times in the case of reference water

    (b)   Start and end times in the case of recycled water

    (c)   Difference between start and end times in the cases of both (a) and (b)

(4)   Ratio of compressive strength of mortar

    (a)   Test method (method A or B specified in 8.1.8)

    (b)   Compressive strength in the case of the reference water (at material ages of 7 and 28 days)

    (c)   Compressive strength in the case of the recycled water (at material ages of 7 and 28 days)

    (d)   Ratio of compressive strength of the mortar using the recycled water to that of the mortar using the reference water

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Related standards:

JIS B 7413	Etched-stem mercury-in-glass thermometers (partial immersion type)
JIS K 0050	General rules for chemical analysis
JIS K 0115	General rules for molecular absorptiometric analysis
JIS K 0121	General rules for atomic absorption spectrochemical analysis
JIS K 8001	General rules for test methods for reagents
JIS K 8005	Reference materials for volumetric analysis
JIS R 3503	Glass apparatus for chemical analysis

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