Recycled aggregate for concrete-Class H

1. Scope

This Japanese Industrial Standard specifies the recycled aggregate for concrete-class H (hereafter referred to as “recycled aggregate H”) manufactured by giving high level treatment such as crushing, grinding and classification to the concrete lumps generated as a result, for example, of pulling down a building.

NOTE : Concrete lumps are generated not only by pulling down buildings but also by hardening the concrete which returned from concrete products and ready mixed concrete.

2. Normative references

The following standards contain provisions which, through references in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS A 0203 *Concrete terminology*
JIS A 1102 *Method of test for sieve analysis of aggregates*
JIS A 1103 *Method of test for amount of material passing test sieve 75 μm in aggregate*
JIS A 1104 *Methods of test for bulk density of aggregate and solid content in aggregate*
JIS A 1109 *Methods of test for density and water absorption of fine aggregates*
JIS A 1110 *Methods of test for density and water absorption of coarse aggregates*
JIS A 1121 *Method of test for resistance to abrasion of coarse aggregate by use of the Los Angeles machine*
JIS A 1144 *Method of test for chloride concentration in water of fresh concrete*
JIS A 1145 *Method of test for alkali-silica reactivity of aggregate by chemical method*
JIS A 1146 *Method of test for alkali-silica reactivity of aggregate by mortar-bar method*
JIS A 1154 *Methods of test for chloride ion content in hardened concrete*
JIS A 1158 *Method for reducing samples of aggregate to testing size*
JIS A 1804 *Methods of test for production control of concrete --- Method of rapid test for identification of alkali-silica reactivity of aggregate*
JIS A 5002 *Lightweight aggregate for structural concrete*
JIS K 8575 *Calcium hydroxide (Reagent)*
JIS K 8576 *Sodium hydroxide (Reagent)*
JIS R 3503 *Glass apparatus for chemical analysis*

JIS R 3505 *Volumetric glassware*

JIS R 5201 *Physical testing methods for cement*

JIS R 5210 *Portland cement*

JIS Z 8801-1 *Test sieves---Part 1 : Test sieves of metal wire cloth*

3. Terms and definitions

For the purpose of this Standard, the terms and definitions given in JIS A 0203 and the following apply.

3.1 original concrete

concrete lump to be a raw material for manufacturing the recycled aggregate

3.2 original aggregate

aggregate contained in the original concrete

3.3 original coarse aggregate

coarse aggregate contained in the original concrete

3.4 original fine aggregate

fine aggregate contained in the original concrete

4. Classification, division and designation

4.1 Classification

The recycled aggregate H is classified as given in Table 1.

Table 1 Classification

Class	Symbol	Remarks
Recycled coarse aggregate H	RHG	Coarse aggregate prepared by giving the original concrete a high level treatment such as crushing and grinding, and performing grading as necessary.
Recycled fine aggregate H	RHS	Fine aggregate prepared by giving the original concrete a high level treatment such as crushing and grinding, and performing grading as necessary.

4.2 Division according to grain size

The recycled aggregate H is divided as given in Table 2 according to the grain size.

Table 2 Division according to grain size

Division	Grain size range mm	Symbol
Recycled coarse aggregate H 4005	40 to 5	RHG4005
Recycled coarse aggregate H 2505	25 to 5	RHG2505
Recycled coarse aggregate H 2005	20 to 5	RHG2005
Recycled coarse aggregate H 1505	15 to 5	RHG1505
Recycled coarse aggregate H 1305	13 to 5	RHG1305
Recycled coarse aggregate H 1005	10 to 5	RHG1005
Recycled coarse aggregate H 4020	40 to 20	RHG4020
Recycled coarse aggregate H 2515	25 to 15	RHG2515
Recycled coarse aggregate H 2015	20 to 15	RHG2015
Recycled coarse aggregate H 2513	25 to 13	RHG2513
Recycled coarse aggregate H 2013	20 to 13	RHG2013
Recycled coarse aggregate H 2510	25 to 10	RHG2510
Recycled coarse aggregate H 2010	20 to 10	RHG2010
Recycled fine aggregate H	5 max.	RHS

4.3 Division according to alkali-silica reactivity

The recycled aggregate H is divided as given in Table 3 according to the alkali-silica reactivity.

Table 3 Division according to alkali-silica reactivity

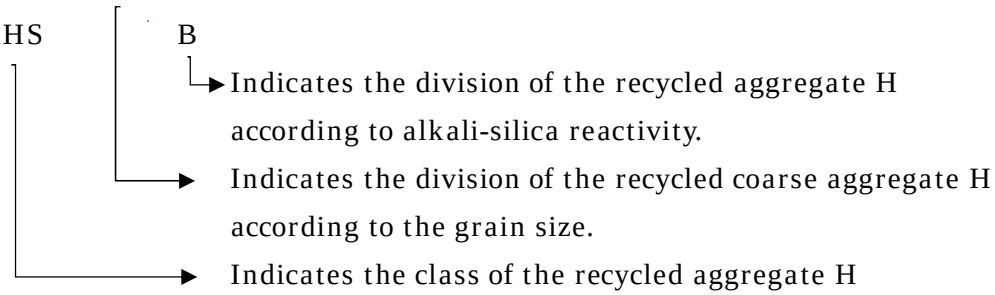
Division	Remarks
A	The recycled aggregate judged as "harmless" in alkali-silica reactivity in accordance with 5.3.
B	Other recycled aggregates than those judged as "harmless" in alkali-silica reactivity in accordance with 5.3.

4.4 Designation

The recycled aggregate H is designated as follows.

Example RHG 2005 A

RHS B



5. Quality

5.1 Amount of impurities

The recycled aggregate H shall not contain harmful amount of impurities that may have an adverse effect on the quality of concrete. The amount of impurities shall satisfy the requirements in table 4 when tested in accordance with 7.2. The amount of aluminium pieces and zinc pieces shall be tested in accordance with 7.3 and shall not exceed 5 mL in the amount of gas generation.

Table 4 Upper limit of the amount of impurities

Classi-fication	Contents of impurities	Upper limit a) %
A	Tiles, bricks, pottery and asphalt concrete lumps	1.0
B	Glass pieces	0.5
C	Gypsum and gypsum board pieces	0.1
D	Other inorganic board pieces than C	0.5
E	Plastics pieces	0.2 b)
F	Wooden pieces, bamboo pieces, cloth pieces, paper scraps and asphalt lumps	0.1
G	Metal pieces other than alminium or zinc	1.0
	Total amount of impurities (total amount of impurities of A to G)	2.0
Notes a)	The upper limit is the value, expressed in mass ratio, of amount of impurity of each classfication relative to the total amount of impurities.	
b)	Some types of plastic have a lower softening point and at elevated temperatures, they can adversely affect the quality of concrete. Therefore, when concrete is to be steam cured or autoclave cured, the upper limit for plastics piece should be set to 0.1 %.	

5.2 Physical properties

The recycled coarse aggregate H and recycled fine aggregate H shall conform to the requirements in Table 5 when tested in accordance with 7.4 to 7.6. The tolerance on the density in oven-dry condition shall be $\pm$0.1g/cm^3 for the value agreed between the manufacturer and the purchaser.

Table 5 Physical properties

Test items		Recycled coarse aggregate H	Recycled fine aggregate H
Density in oven-dry condition a)	g/cm^3	2.5 min.	2.5 min.
Percentage of water absorption a)	%	3.0 max.	3.5 max.
Abrasion loss b)	%	35 max.	—
Content of material finer than 75 μm seive	%	1.0 max.	7.0 max.
Note a) Even in one of the test carried out in accordance with 7.4, the result shall conform to the requirements in table 5.			
b) Applicable to the case of using pavement.			

5.3 Alkali-silica reactivity

5.3.1 Alkali-silica reactivity of recycled coarse aggregate H

When being in compliance with all of the following requirements, the alkali-silica reactivity of recycled coarse aggregate H is judged as harmless.

a) All the original coarse aggregates are identified.
"Identification of original aggregate" is given in Annex A.

b) All the original coarse aggregates or recycled coarse aggregates H are judged as harmless by the alkali-silica reactivity test given in 7.7.
Alkali-silica reactivity test for original coarse aggregate shall be carried out for every original coarse aggregate specified at a).

5.3.2 Alkali-silica reactivity of recycled fine aggregate H

When being in compliance with all of the following requirements, the alkali-silica reactivity of recycled fine aggregate H is judged as harmless.

a) All the original coarse and fine aggregates are identified. "Identification of original aggregate" is given in Annex A.

b) All the original coarse and fine aggregates, or recycled fine aggregates H are judged as harmless by the alkali-silica reactivity test given in 7.7.
Alkali-silica reactivity test for original coarse and fine aggregate shall be carried out for every original aggregate specified at a).

5.4 Grain size

5.4.1 Grain size

The grain size of the recycled aggregate H shall be tested in accordance with 7.8 and shall be within the range given in Table 6. The manufacturer may consult with the purchaser to change the range of the mass fraction of those which pass the sieve for each division according to the grain size.

The specified range in Table 6 is applicable to those retained on the sieve of nominal size 75 μm.

Table 6 Grain size

Division	Mass fraction of those passing through sieve %												
	Nominal sieve size a) mm												
	50	40	25	20	15	13	10	5	2.5	1.2	0.6	0.3	0.15
Recycled coarse aggregate H4005	100	95 to 100		35 to 70			10 to 30	0 to 5					
Recycled coarse aggregate H2505		100	95 to 100		30 to 70			0 to 10	0 to 5				
Recycled coarse aggregate H2005			100	90 to 100			20 to 55	0 to 10	0 to 5				
Recycled coarse aggregate H1505				100	90 to 100		40 to 70	0 to 15	0 to 5				
Recycled coarse aggregate H1305					100	85 to 100		0 to 15	0 to 5				
Recycled coarse aggregate H1005						100	90 to 100	0 to 15	0 to 5				
Recycled coarse aggregate H4020	100	90 to 100	20 to 55	0 to 15			0 to 5						
Recycled coarse aggregate H2515		100	95 to 100		0 to 15		0 to 5						
Recycled coarse aggregate H2015			100	90 to 100	0 to 15		0 to 5						
Recycled coarse aggregate H2513		100	95 to 100			0 to 15	0 to 5						
Recycled coarse aggregate H2013			100	85 to 100		0 to 15	0 to 5						
Recycled coarse aggregate H2510		100	95 to 100				0 to 10	0 to 5					
Recycled coarse aggregate H2010			100	90 to 100			0 to 10	0 to 5					
Rcycled fine aggregate H							100	90 to 100	80 to 100	50 to 90	25 to 65	10 to 35	2 to 15

Note a) The nominal sieve sizes in the table correspond to the nominal sieve apertures specified in JIS Z 8801-1, namely, 53mm, 37.5 mm, 26.5 mm, 19 mm, 16 mm, 13.2mm, 9.5 mm, , 4.75 mm, 2.36 mm, 1.18 mm, 600 μm, 300 μm, and 150 μm, respectively.

5.4.2 Fineness modulus

The tolerance on the fineness modulus in the recycled aggregate H shall be±0.20 of the fineness modulus agreed between the manufacturer and the purchaser. Where the recycled coarse aggregate H is used by mixing with gravel, crushed stone, etc. or the recycled fine aggregate H with sand, crushed sand, etc., the manufacturer may relax the tolerance on the fineness modulus upon consultation with the purchaser.

5.4.3 Quantity which remains on adjacent sieves

The recycled fine aggregate H shall be such that, in any of the sieves given in Table 6, the difference from the volume which remains on the adjacent sieve is not over 45 %.

5.5 Grain shape

The grain shape shall be as follows.

a) The solid volume percentage for shape determination of the recycled coarse aggregate H shall be tested in accordance with 7.9 and the result, including the tolerance, shall be at least 55 %. The tolerance to be applied shall be±1.5 % of the value agreed between the manufacturer and the purchaser. When the recycled coarse aggregate H is used by mixing with gravel, crushed stone, etc., the manufacturer may relax the tolerance on solid volume percentage for shape determination upon consultation with the purchaser.

b) The solid volume percentage for shape determination of the recycled fine aggregate H shall be tested in accordance with 7.9 and the result, including the tolerance, shall be at least 53 %. The tolerance to be applied shall be±1.5 % of the value agreed between the manufacturer and the purchaser. When the recycled fine aggregate H is used by mixing with sand, crushed sand, etc., the manufacturer may relax the tolerance on solid volume percentage for shape determination upon consultation with the purchaser.

5.6 Chloride content

The chloride content[1)] in recycled aggregate H shall not exceed 0.04 % when tested in accordance with 7.10. However, this maximum limit may be set at under 0.1 % if approved by the purchaser.

Note[1)] Indicated as a value converted to NaCl.

6. Manufacture

The manufacture of recycled aggregate H shall be as follows.

a) The original concrete showing evident signs of abnormalities that can be attributed to the aggregate, such as alkali-silica reactivity, shall not be used.

b) The original concrete containing a lot of chloride shall not be used.

c) The original concrete containing a number of impurities shall not be used.

d) The original concrete not fully hardened shall not be used.

e) The original concrete that is chemically contaminated shall not be used.

f) The light-weight aggregate concrete shall not be used for the original concrete.

g) Sea water shall not be used for cleaning water.

h) The recycled aggregate H shall be stored in such a way as to prevent segregation and impurity incorporation.

i) The recycled aggregate H of division A in alkali-silica reactivity shall be handled so as not to be mixed with the recycled aggregate H of division B during storage of the original concrete and at each stage of manufacture, storage and shipment of the recycled aggregate H.

7. Test method

7.1 Sampling of specimen

The specimen to be taken shall be a representative part of the recycled aggregate H and shall be reduced by a method in accordance with JIS A 1158.

7.2 Test of amount of impurities

The test shall be in accordance with Annex B.

7.3 Test of judgement for harmful amount of aluminium pieces and zinc pieces

The test shall be in accordance with Annex C.

7.4 Test of density in oven-dry condition and percentage of water absorption

The test shall be performed in accordance with JIS A 1109 or JIS A 1110. The difference from the mean value of two tests is allowed to be 0.02g/㎤ or under in the case of the density in oven-dry condition and 0.2 % or under in the case of the percentage of water absorption.

7.5 Abrasion test

The test shall be performed in accordance with JIS A 1121.

7.6 Test of content of materials finer than 75 μm sieve

The test shall be performed in accordance with JIS A 1103.

7.7 Test of alkali-silica reactivity

The test shall be performed in accordance with JIS A 1145, JIS A 1146 or Annex D. When carrying out the test of alkali-silica reactivity according to JIS A 1145, the cement paste adhered to the original aggregate or recycled aggregate H shall be removed by dissolving with hydrochloric acid or the like and then washing with water prior to testing.

Judgement of alkali-silica reactivity when the test is performed according to JIS A 1145 or JIS A 1146 shall be made as follows.

a) **In test performed according to JIS A 1145** Judgement shall be made based on the average of the determined values of the measurement items. In the range where the amount of dissolved silica (Sc) is 10mmol/L or over and the amount of alkali concentration decrease (Rc) is under 700mmol/L, the aggregate shall be judged as “harmless” if the amount of dissolved silica (Sc) is less than the amount of alkali concentration decrease (Rc). However if the amount of dissolved silica (Sc) is equal to or greater than the amount of alkali concentration decrease (Rc) in the same range, the aggregate shall be judged as “not harmless”. When the amount of dissolved silica (Sc) is under 10mmol/L and the amount of alkali concentration decrease (Rc) is under 700mmol/L, the aggregate shall be judged as “harmless”. When the amount of alkali concentration decrease (Rc) is 700mmol/L or over, judgement shall not be made on that aggregate.

b) **In test performed according to JIS A 1146** When the average expansion coefficient of three specimens in 26 weeks is under 0.100 %, the aggregate shall be judged as “harmless” and when it is 0.100 % or greater, it shall be judged as “not harmless”. When the aggregate shows expansion of 0.050 % or greater at the material age of 13 weeks, it shall be judged as

"not harmless" at that point, and measurement at the material age of 26 weeks may be omitted.

7.8 Test of sieve analysis

The test shall be performed in accordance with JIS A 1102.

7.9 Test of solid volume percentage for shape determination

The test shall be performed as follows.

a) The specimens of the recycled coarse aggregate H shall be prepared using recycled coarse aggregate H2005 by drying to an oven-dry condition and sieving to divide it into the groups of 24 kg of 20 mm to 10 mm grains and 16 kg of 10 mm to 5 mm grains and then mixing them fully. The specimens of the recycled fine aggregate H shall be prepared by sieving and thoroughly washing with water and taking those which have passed through the sieve of nominal size 2.5 mm but remained on the sieve of nominal size 1.2 mm and bringing it to an oven-dry condition.

b) The bulk density of the specimens shall be obtained by the method specified in JIS A 1104.

c) For the density in oven-dry condition of the specimen, the value obtained in 7.4 shall be used.

d) The solid volume percentage for shape determination shall be calculated by the following formula :

$$G = \frac{T}{d_D} \times 100$$

where, G : solid volume percentage for shape determination (%)
T : bulk density of the specimen (kg/L)
d_D : density in oven-dry condition (g/㎤)

7.10 Test of chloride content

The test shall be performed by either the followings.

a) The test shall be in accordance with 5.5 of JIS A 5002. However the analysis of chloride content (chloride ion concentration) in the specimen shall be in accordance with Clause 4 (analyzing method) of JIS A 1144.

The quantity of the specimen shall be 1,000 g and 4/3 times the test result values shall be taken as the chloride content.

b) The test shall be in accordance with JIS A 1154.

8 Inspection

8.1 Inspection method

The inspection of recycled aggregate H shall be as follows.

a) For inspection, the lot size shall be determined for each class by agreement between the

manufacturer and the purchaser, the specimen shall be taken in accordance with a reasonable sampling plan, the test shall be carried out as specified in Clause 7 and those which conform to the requirements in Clause 5 are accepted.

b) The maximum value of a lot shall be the amount which can be manufactured in two weeks.

c) Alkali-silica reactivity for all types of original aggregate or recycled aggregate H shall be confirmed by the test given in 7.7. However the maximum value of a lot in alkali-silica reactivity test or the target may be changed as shown in 1) to 5) blow depending on the condition.

1) For recycled aggregate H which has been judged as harmless in three consecutive alkali-silica reactivity test, the maximum value of a lot in any subsequent alkali-silica reactivity test may be the amount that can be manufactured in 1 month.

2) For recycled aggregate H for which it is certified by a test certificate or the like that all of the original coarse aggregates is judged as harmless in alkali-silica reactivity, the maximum value of a lot in the alkali-silica reactivity test may be the amount that can be manufactured in 3 months.

3) For recycled fine aggregate H for which it is certified by a test result certificate or the like that all of the original coarse aggregates and original fine aggregates are judged as harmless in alkali-silica reactivity, the maximum value of a lot in the alkali-silica reactivity test may be the amount that can be manufactured in 3 months.

4) When all of the original coarse aggregates taken by the original concrete has been judged as harmless in the alkali-silica reactivity test in 7.7, the alkali-silica reactivity test may be omitted.

5) When all of the original coarse and fine aggregates taken by the original concrete have been judged as harmless in the alkali-silica reactivity test in 7.7, the alkali-silica reactivity test may be omitted.

d) For aggregates used for pavement boards, when the original coarse aggregate can be identified, the maximum value of a lot in the abrasion test shall be the amount that is manufactured by the same original aggregate.

8.2 Preservation of inspection data

The manufacturer shall store the records of the test results obtained in the inspection for a specified period.

9. Marking

The marking shall be as follows.

a) In the invoice of recycled aggregate H, the following information shall be given.

1) Class and division (according to the designation in 4.4)

2) Name of manufacturer, name of manufacturing factory and its address
3) Time of manufacture and date of shipment
4) Mass or volume
5) Name of the company and factory of consignee

b) Address where the original concrete was produced. However if the original aggregate can be identified or if necessary.

10. Report

The manufacturer shall present the test result certificate if requested by the purchaser. The standard format of the test result certificate shall be shown in Table 7 or Table 8.

Annex A (normative)

Identification of original aggregate

A.1 General

This Annex specifies the methods for identifying the original aggregate of the recycled aggregate H for concrete.

A.2 Method for identification

The original aggregate shall be identified for each construction as stated below.

a) **Where the record on the original aggregate is accessible** If the class and place of production or name of product of the original aggregate can be identified by such as the work record of the demolished construction, the mix proportion report of the original concrete, the test result certificate of the original aggregate, etc., the original aggregate is regarded as identified.

b) **Where no record on the original aggregate is accessible** If the class and place of production or name of product of the original aggregate cannot be identified by such as the work record of the demolished construction, the mix proportion report of the original concrete, the test result certificate of the original aggregate, etc., a portion of the original concrete shall be taken according to A.3 on which observation shall be made for the color, shape and size of the original aggregate. If, as a result of this observation, the class and number of the original aggregates are successfully identified, the all the original aggregates contained in the original concrete are regarded as identified, although with unknown place of production and name of product.

A.3 Sampling method of original concrete

The sampling of the original concrete shall be in accordance with either of the followings.

a) **Where sampling from constructions**

1) Using a core drill for concrete or a cutter for concrete, a portion of the original concrete shall be taken in such a size that the identification of the color, shape and size of the original aggregate is possible.

2) The original concrete shall be sampled at at least one position of each floor and of a wall or pillar on each floor in the case of a building, and at at least one position of each placing division in the case of civil engineering construction. If the amount of concrete at the sampling division exceeds 1,000 m^3, sampling shall be made at at least one position in each 1,000 m^3.

b) **Where sampling from concrete lumps**

1) At the timing of receiving concrete lumps, a portion of the original concrete shall be taken in such a size that the identification of the color, shape and size of the original aggregate is possible.
2) The sampling shall be taken more than one time per each 10t of concrete lumps.

Annex B (normative)

Test method for impurities of recycled aggregate H by means of boundary sample

B.1 General

This Annex specifies the test of impurities of the recycled aggregate H for concrete.

B.2 Specimen

B.2.1 Sampling of specimen

The recycled aggregate H shall be sampled so as to represent the lot being tested. The sample then shall be reduced approximately to a specified amount in accordance with JIS A 1158.

B.2.2 Size of specimen

The minimum mass of the specimen shall be 10 kg in the case of recycled coarse aggregate H and 500g in the case of recycled fine aggregate H.

B.3 Test method

The specimen which spread wide enough for impurities to be clearly identified by visual observation over a saucer or the like shall be visually compared with the boundary samples specified in B.4 indicating the upper limit of the amount of each impurity, and the amount of each impurity shall be estimated[1)]. In estimation of amount of metal pieces other than aluminium or zinc pieces, if distinguishing them from the aluminium or zinc pieces is difficult, the estimation may include the amount of aluminium and zinc pieces. If visual determination of impurities is difficult by reason of dryness, bring the specimen into a wet state by, for example, spraying water. The total of the estimated amounts of all the impurities shall be taken as the total amount of impurities.

Note[1)] The amount of each impurity may be determined from mass measurement of the impurity.

B.4 Method for preparation of boundary samples

Samples containing respective impurities given in Table 4 shall be prepared by adding each of the impurities to impurity-free recycled coarse aggregate H or recycled fine aggregate H of which amount shall be as given in B.2.2, up to their respective upper limit. The size and shape of the impurities shall simulate such size and shape as contained in the recycled coarse aggregate H and recycled fine aggregate H after manufacture. If any impurity considered to be in nonconformity with the classification in Table 4 is expected to be contained, another boundary

sample shall be prepared separately. For comparison, the photograph of the prepared boundary sample which spread as same size of B.3 may be used.

NOTE : In addition to the boundary samples containing the upper limit amount of impurities, those containing half the upper limit amount of impurities may be prepared for convenience in judgement.

Note[2] : When identification is difficult by a photograph, the impurities in the boundary sample or in the photograph should be colored as necessary.

Annex C (normative)

Testing method of judgement for harmful amount of aluminium pieces and zinc pieces contained in recycled aggregate for concrete-class H

C.1 General

This Annex specifies the testing method of judgement for harmful amount of aluminium pieces and zinc pieces contained in recycled aggregate-class H.

C.2 Testing instrument

C.2.1 Erlenmeyer flask

An Erlenmeyer flask as specified in JIS R 3503, 1,000ml in capacity and not less than 25mm in inside diameter at the neck part.

C.2.2 Pipette

A pipette as specified in JIS R 3505, not less than 20ml in capacity and graduated in 0.1ml.

C.2.3 Perforated rubber stopper

A perforated rubber stopper provided with a hole through which a pipette can be inserted without any clearance.

C.2.4 Calcium hydroxide

The calcium hydroxide as specified in JIS K 8575.

C.3 Specimen

C.3.1 Sampling of specimen

The recycled aggregate H shall be sampled so as to represent the lot being tested, and that which has passed through a sieve of nominal size of 20mm shall be supplied as the specimen.

C.3.2 Reduction of specimen

The specimen shall be reduced approximately to the specified amount given in accordance with JIS A 1158.

C.3.3 Amount of specimen

The specimen for test shall be 1,000g in air-dried mass.

C.3.4 Conditioning of specimen

The specimen for test shall be immersed in water for 24 h or longer before the start of test so that it absorbs sufficient water.

C.4 Test method

The test method shall be as follows.

a) The temperature of laboratory and the temperature of water shall be 20℃±3℃.

b) Put the specimen for test in an Erlenmeyer flask, pour 600 ml of water and shake the Erlenmeyer flask lightly.

c) Insert a pipette in a perforated rubber stopper, attach it to the Erlenmeyer flask and adjust so that the tip of the pipette is immersed in water to a depth of at least 1 cm.

d) Detach the rubber stopper with the inserted pipette from the Erlenmeyer flask, add 0.5 g of calcium hydroxide to the Erlenmeyer flask and shake the Erlenmeyer flask lightly.

e) Quickly attach the rubber stopper with the inserted pipette to the Erlenmeyer flask, leave it to stand for 10 min, read the graduation of the water level of the pipette to the nearest 0.1 ml and take it as the initial value.

f) In 24 h elapse after the addition of calcium hydroxide, shake the Erlenmeyer flask lightly, read the graduation of water level of pipette to the nearest 0.1 ml and take the difference from the initial value as the amount of gas generation.

C.5 Report

The report shall including the necessary from among the following.

a) The producer's name of recycled aggregate H

b) The position, date and time of sampling the recycled aggregate H

c) The amount of gas generation (ml)

d) The date of test

Annex D (normative)

Test method for alkali-silica reactivity of recycled aggregate for concrete-class H

(recycled aggregate rapid method)

D.1 General

This Annex specifies the method of rapidly measuring the alkali-silica reactivity of the recycled aggregate for concrete-class H by curing mortar bar at high temperature and high pressure and measuring the change of its characteristics.

D.2 Testing instrument

The testing instrument shall be in accordance with Clause 3 (Testing instrument) of JIS A 1804.

D.3 Specimen

The preparation of specimen shall be as follows.

a) Take about 40 kg of representative portion from the recycled coarse aggregate H and the recycled fine aggregate H.

b) Mix well the 40 kg of recycled aggregate H and reduce it to about 10 kg in accordance with JIS A 1158.

c) Wash the reduced recycled aggregate H, and after bringing it to an oven-dry condition, grind it coarsely by a sand-manufacturing machine until the whole amount has passed through a 5 mm sieve. Mix this well, and reduce to about 5 kg by quartering or by means of a sample splitter and take it as the representative specimen.

d) Grind the representative specimen by the sand-manufacturing machine successively and classify according to the grain size indicated in Table D.1.

After the specified amount of specimen is taken, the residual representative specimen shall be ground until the whole amount has passed through the remaining sieve.

e) Wash the representative specimens of each grain size with water, remove the minute particles, then bring it to an oven-dry condition.

f) Mix the representative specimens of each grain size in the oven-dry condition so as to be in accordance with the grain size distribution indicated in Table D.1, and take it as the test specimen.

g) The test specimen shall be supplied for the test in the oven-dry condition or in the air-dried condition.

Table D.1 Grain size distribution of graded test specimen

Nominal opening of sieve		Mass fraction
Passed	Remained	%
4.75mm	2.36mm	10
2.36mm	1.18mm	25
1.18mm	600μm	25
600μm	300μm	25
300μm	150μm	15

D.4 Material

The material shall be as follows.

a) **Cement** The normal portland cement specified in JIS R 5210, of which the total alkali amount Na_2Oeq is (0.50±0.05) %, and the ratio of Na_2O (%) to K_2O (%) is in the range of 1 : 1 to 1 : 2.5 shall be used.

b) **Standard sand** The standard sand specified in 11.3 of JIS R 5201 shall be used.

c) **Sodium hydroxide** The aqueous solution prepared using the reagent specified in JIS K 8576 shall be used. A.2 mol/L aqueous solution of sodium hydroxide which is available on the market may also be used.

d) **Water** The water used for mixing of mortar and that used for adjusting the concentration of the aqueous solution of sodium hydroxide shall be the city water.

D.5 Preparation and curing of specimen

D.5.1 Mix proportion number and mix proportion of mortar

The mix proportion number and mix proportion of mortar for each measuring method shall be as follows.

a) **For measurement of ultrasonic propagation velocity or dynamic modulus of elasticity**

1) **Mix proportion number of mortar** The mix proportion number of mortar shall be one and the constitution ratio of fine aggregate shall be in accordance with the constitution condition of fine aggregate 1 indicated in Table D.2.

2) **Mix proportion of mortar** The mix proportion of mortar shall be such that the mass ratio of cement, water and fine aggregate (standard sand + test specimen) is 1 : 0.5 : 2. The amount of cement, water + sodium hydroxide aqueous solution, fine aggregate (standard sand + test specimen) mixed in one time shall be as follows.

The amount of sodium hydroxide aqueous solution shall be determined by calculating so that the total alkali amount of cement becomes 2.50 % in Na_2Oeq.

Cement	: 600 g ± 1 g
Water + sodium hydroxide aqueous solution	: 300 ml ± 1ml
Fine aggregate (standard sand + test specimen)	: 1,200 g ± 1 g

b) **For measurement of change rate of length**

1) **Mix proportion number of mortar** The mix proportion number of mortar shall be four, with the constitution ratio of fine aggregate changed. The test shall be first carried out with the fine aggregate constitution condition 1 in Table D.2, and depending on the result, additional tests shall be carried out with the constitution conditions 2 to 4 as necessary.

2) **Mix proportion of mortar** The mix proportion of mortar shall be in accordance with a) 2).

Table D.2 Constitution ratio and mass of fine aggregate (standard sand, test apecimen)

Constitution condition of fine aggregate	Constitution ratio of fine aggregate (mass ratio)		Mass of fine aggregate g		
	Standard sand	Test specimen	Standard sand	Test specimen	Total
1	50	50	600	600	1,200
2	0	100	0	1,200	1,200
3	25	75	300	900	1,200
4	75	25	900	300	1,200

D.5.2 Mixing of mortar

Fix the mixing bowl and the paddle at the mixing position and put in the specified amount of cement and fine aggregate. Start the mixer and perform mixing by rotating the paddle for 30 s. Next, stop the mixer and pour the specified amount of water with the sodium hydroxide aqueous solution. Continue to operate the mixer for 30 s, then stop it for 20 s. During the stop, scrape off the mortar adhered to the mixing bowl and the paddle by a spoon. Then, stir the mortar in such a way as to scoop up from the bottom of bowl. After the stop, start the mixer again and perform mixing for 120 s.

The rotation speed of the paddle, for any case, shall be a low speed (rotation speed : 140 r.p.m ±5 r.p.m, revolution speed : 62 r.p.m ± 5 r.p.m).

D.5.3 Preparation and curing of specimen

The preparation and curing of specimen shall be as follows.

a) The mortar shall be immediately cast into the formwork in two layers. Compact the mortar to half the height of the formwork and strike 15 times each layer of every specimen by using a ram such that its tip goes into the mortar to a 5mm depth in each strike. The number of striking

shall be reduced if separation of mortar is feared. In the vicinity of the gauge plug, special attention shall be paid to spread the mortar sufficiently by performing spacing or the like. Next, place additional mortar up to a height of about 5mm above the upper end of the formwork, and strike with a ram in a similar manner to the first time. Finish the surface of this specimen within about 20 min after forming.

b) Prepare three specimens of rectangular parallelepiped of 40 mm×40 mm×160 mm (when the change of length is measured, a gauge plug may be attached). After forming, cure the specimens in a humid box at 20℃±2℃ in temperature and not less than 95 % in relative humidity for 24 h, then remove the formwork, and immediately carry out curing in water at 20℃ ±2℃ for 24 h.

D.6 Test method

The test method shall be in accordance with Clause 5 (Test method) of JIS A 1804.

D.7 Calculation

The calculation shall be in accordance with Clause 6 (Calculation) of JIS A 1804.

D.8 Precision

The precision shall be in accordance with Clause 7 (Precision) of JIS A 1804.

D.9 Judgement

The judgement shall be as follows.

a) **For measurement of ultrasonic propagation velocity or dynamic modulus of elasticity** The judgment shall be made on the rate of ultrasonic propagation velocity or the coefficient of relative dynamic modulus of elasticity which is the mean value of test results of three specimens of fine aggregate constitution condition 1 indicated in Table D.2rounded off to an integer. When the following conditions are satisfied, judgement shall be “harmless”, and when not satisfied, judgement shall be “not harmless”.

1) The rate of ultrasonic propagation velocity is not less than 95 %.
2) The coefficient of relative dynamic modulus of elasticity is not less than 85 %.

b) **For measurement of change rate of length** When the change rate of length, which is the mean value of the test results of three specimens of fine aggregate constitution condition 1 indicated in Table D.2 rounded off to two decimal places, is 0.07 % or less, judgement shall be “harmless”, and when the value is exceeding 0.07 %, judgement shall be “not harmless”. However, when the change rate of length is exceeding 0.07 % but less than 0.10 %, additional tests shall be carried out with fine aggregate constitution conditions 2 to 4 indicated in Table D.2, and if all the results of the fine aggregate constitution conditions 1 to 4 turn out to be under 0.10 %, judgement shall be “harmless”.

D.10 Report

The report shall include the necessary information from among the following.

a) The class and division of recycled aggregate H

b) The name of the manufacturer of recycled aggregate H, the name of the manufacturing plant and its location

c) The location of production of original concrete

d) The sampling place and date of recycled aggregate H

e) The total alkali of cement [potassium oxide (K_2O), sodium oxide (Na_2O), total alkali (%)]

f) The curing temperature (℃)

g) The curing time (h)

h) The date of test (period of test)

i) The measuring method and the constitution ratio of fine aggregate

j) The test results before and after boiling (%)

k) The judgement results

l) The other matters to be noted which have been discovered by observation of specimen after testing.