UDC 666.972.125:620.16:531.754
:620.16:543.71

JAPANESE INDUSTRIAL STANDARD J I S

Methods of Test for Bulk Specific Gravity and Absorption of Light Weight Coarse Aggregates for Structural Concrete

A 1135-1989

1. Scope

This Japanese Industrial Standard specifies the method of test for bulk specific gravity and water absorption percentage of lightweight coarse aggregates for structural concrete.

2. Test Appliances

2.1 The balance to serve shall have a weighing capacity not smaller than 5 kg and a reciprocal sensibility within 0.5 g.

2.2 The cage for holding the coarse aggregates shall be made of a wire screen 3 mm or smaller in aperture size, about 20 cm in diameter, about 20 cm in height and fitted with a cover where required.

2.3 The water tank used shall have a size suitable for the cage to be immersed in the water.

2.4 The balance shall be provided with a suitable device for suspending the cage from the center of the pan.

3. Sample

3.1 Take a representative sample of the coarse aggregates whose particles remain on a wire sieve 5 mm in size ([1]) in the air-dried condition and reduce it to about the specified quantity by the method of quartering or by the use of a sample splitter. The required mass shall be about 4 kg ([2]). Further divide this into two equal parts of about 2 kg by the use of a sample splitter.

Notes ([1]) The sieve shall be the 4.75 mm standard sieve specified in JIS Z 8801.

([2]) This quantity is for two test runs of the specific gravity and water absorption percentage. Where the maximum size of the coarse aggregates exceeds 25 mm, this weight shall be made about 8 kg.

Applicable Standards:

JIS Z 8401-Rules for Rounding off of Numerical Values

JIS Z 8801-Test Sieves

3.2 Wash the sample of 3.1 thoroughly with water removing dust and the like from the particle surfaces, and dry at 100 to 110°C until a constant mass is obtained.

3.3 Cool the sample of 3.2 to room temperature, immerse in still water at 15 to 25°C allowing to absorb water for at least 24 h, roll on a cloth with a strong water absorbing property to divest of visible water films, and take the condition of the sample thus obtained as the saturated surface-dry condition.

3.4 Divide the sample of 3.3 into two equal parts and use each part as the sample for one test run of bulk specific gravity and water absorption percentage.

4. Test Method

4.1 Measure the mass (m_s) of the sample of 3.4.

4.2 Put the sample of 4.1 in the cage and immerse in water, apply the cover in the case where particles float on the water surface, and promptly measure the virtual mass in water (m_w) of the sample.

4.3 Take the sample out of the water, dry at 100 to 110°C until a constant mass is obtained, then cool to room temperature in a desiccator, and measure its mass (m_D).

5. Calculation of Results

5.1 The results of the test shall be calculated from the following formulas and rounded off to 3 significant figures in accordance with JIS Z 8401. However, the water absorption percentage shall be rounded off to the nearest 0.1.

$$D_S = \frac{m_S}{m_S - m_w}$$

$$D_D = \frac{m_S \left(\frac{100}{100+Q}\right)}{m_S - m_w}$$

$$Q = \frac{m_S - m_D}{m_D} \times 100$$

where, D_S: specific gravity in saturated surface-dry condition

D_D: specific gravity in absolute dry condition

Q: water absorption (mass percentage) (%)

m_S: mass of sample in saturated surface-dry condition (g)

m_w: virtual mass in water of sample (g)

m_D: mass of sample after drying (g).

5.2 The test for specific gravity and water absorption percentage shall be performed each two times with the sample taken at the same time and the measured values shall be averaged.

6. Precision

The deviation from the mean value shall be within 0.02 in the case of the specific gravity test, and within 0.1 % in the case of the water absorption test.

7. Report

The following information items shall be included in the report as required.

(1) Kind, particle size, appearance, and name of lightweight aggregates

(2) Sampling position and date and time

(3) Time duration of water absorption of aggregates in the test

(4) Specific gravity

(5) Water absorption percentage.

UDC 666.972.12:620.168.3:666.32

JAPANESE INDUSTRIAL STANDARD

J I S

Method of Test for Clay Contained in Aggregates

A 1137-1989

1. Scope

This Japanese Industrial Standard specifies the method of test for the clay contained in aggregates.

2. Test Appliances

2.1 The balance used shall have a precision within 0.1 % of the total mass of the sample.

2.2 The sieves used shall be wire sieves 0.6 mm, 1.2 mm, 2.5 mm and 5 mm in size, respectively([1]).

Note ([1]) These sieves shall respectively correspond to the standard sieves 600 μm, 1.18 mm, 2.36 mm and 4.75 mm in size specified in JIS Z 8801.

3. Sample

3.1 Take a sample of the aggregates representative of lot to be tested and from each sample separately take a quantity not smaller than the mass shown in 3.3 by the method of quartering or by means of a sample splitter. In this operation, care shall be taken not to crush the clay lumps contained in the aggregates.

3.2 The aggregates taken separately shall be dried gradually at room temperature to an air-dried condition.

3.3 Use as the sample the particles remaining on the 1.2 mm wire sieve in the case of fine aggregates, and on the 5 mm wire sieve in the case of coarse aggregates. The quantity of the sample of fine aggregates shall be not less than 1000 g, and that of the sample of coarse aggregates shall be not less than the quantity shown in Table according to the maximum size.

Table

Maximum size of coarse aggregates mm	Mass of sample kg
10 or 15	2
20 or 25	6
30 or 40	10
Over 40	20

Applicable Standards:

JIS Z 8401-Rules for Rounding off of Numerical Values

JIS Z 8801-Test Sieves

3.4 The sample of 3.3 shall be divided into two equal parts and each part shall be used as the sample for one test run.

4. Test Method

4.1 Place the sample of 3.4 in a container, dry at 100 to 110° C to a constant mass, and accurately measure its mass (m_{D2})(2) to the nearest 0.1 %.

Note (2) The mass in this operation shall include the mass of fine particles and powder of clay lumps broken loose by drying.

4.2 Spread the sample over the container bottom in a thin layer and add water so that it covers the thin layer.

4.3 After the sample has absorbed water for 24 h, drain the remaining water, and examine the aggregate particles by pressing with fingers(3). The pieces which can be crushed into fine pieces by pressing with fingers shall be duly taken as clay lumps.

Note (3) The operation of crushing the clay lumps in the coarse aggregates can be facilitated by preliminarily screening the coarse aggregates into several particle groups according to the maximum size of the aggregates.

4.4 After crushing all the clay lumps, wash the sample with water on a 0.6 mm wire sieve in the case of fine aggregates, and on a 2.5 mm wire sieve in the case of coarse aggregates.

4.5 Dry the particles remaining on the sieve at 100 to 110° C until a constant mass is obtained, and measure their mass (m_{D2}) accurately to the nearest 0.1 %.

5. Calculation of Result

5.1 The clay content shall be calculated from the following formula and rounded off to one decimal place in accordance with JIS Z 8401.

$$C = \frac{m_{D1} - m_{D2}}{m_{D1}} \times 100$$

where, C : clay content (%)

m_{D1} : dry mass of sample before test (g)

m_{D2} : dry mass of sample after test (g).

5.2 The test shall be conducted two times and the measured values shall be averaged.

6. Precision

The deviation from the mean value shall be within 0.2 %.

7. Report

Items of information in the following as considered necessary shall be written in the report.

(1) Kind, size, appearance, and locality of occurrence of the aggregates. In the case of artificial lightweight aggregates, the name of product([4]).

(2) Date of test

(3) Clay content (%)

(4) Information on the conditions of aggregates related to the test([5])

Note ([4]) The name of the product may be a trade name.

([5]) For example, there are cases in which the clay lumps scattered in fine aggregates are not always contained in the sample taken. In addition, clay or the like adhering to the surfaces of coarse aggregate particles will influence the test values. such conditions shall be included in the test report.

(A 15) UDC 666.972.125

JAPANESE INDUSTRIAL STANDARD J I S

Light Weight Aggregates for Structural Concrete

A 5002-1978
(Reaffirmed: 1988)

1. Scope

This Japanese Industrial Standard specifies the light-weight aggregates for structural light-weight concrete. The structural light-weight concretes mentioned here mean the concretes to be used in structurally principal places and these are the concretes to be used for reinforced light-weight concrete structures, pre-stressed light-weight concrete structures, steel-framed reinforced light-weight concrete structures, pre-cast light-weight concrete products, etc.

Remark: In this standard, units and numerical values given in { } are in accordance with the International System of Units (SI), and are given for reference.

2. Classification and Designation

2.1 The light-weight aggregates are classified as shown in Tables 1 to 5.

Table 1. Classification by Materials

Classification	Description
Artificial light-weight aggregates	Expanded shale, expanded clay, expanded slate sintered fly ash, etc.
Natural light-weight aggregates	Lapilli and processed products thereof
By-product light-weight aggregates	By-product light-weight aggregates of expanded slag and the like and processed products thereof

Table 2. Classification of Aggregates by Absolute Dry Specific Gravity

Classification	Absolute dry specific gravities (refer to 4.10)	
	Fine aggregates	Coarse aggregates
L	Less than 1.3	Less than 1.0
M	1.3 to 1.8 excl.	1.0 to 1.5 excl.
H	1.8 to 2.3 excl.	1.5 to 2.0 excl.

Applicable Standards: See page 9.

Table 3. Classification of Aggregates by Solid Content

Unit : %

Classification	Solid content of fine aggregates in mortar (refer to 4.11)	Solid content of coarse aggregates (refer to 4.12)
A	50.0 or more	60.0 or more
B	45.0 to 50.0 excl.	50.0 to 60.0 excl.

Table 4. Classification by Compressive Strength as Concrete

Unit : kgf/cm^2 {MPa}

Classification	Compressive strength (refer to 4.13)
400	400 {39.2} or over
300	300 {29.4} to 400 {39.2} excl.
200	200 {19.6} to 300 {29.4} excl.
100	100 { 9.8} to 200 {19.6} excl.

Table 5. Classification by Mass of Unit Volume of Concrete

Unit : kg/ℓ

Classification	Mass of unit volume (refer to 4.13)
15	Less than 1.6
17	1.6 to 1.8 excl.
19	1.8 to 2.0 excl.
21	2.0 or more

2.2 Designation The light-weight aggregates are designated as following examples:

Examples: Artificial light-weight fine aggregates MA-417; artificial light-weight coarse aggregates MA-419 (river sands) ([1]); natural light-weight coarse aggregates HB-121; by-product light-weight coarse aggregates LB-219.

Note ([1]) Type of fine aggregates used is to be added, if required.

3. Qualities

3.1 The light-weight aggregates shall be clean, durable and fire-resisting.

3.2 The light-weight aggregates shall not contain any substance infectious to the concrete and steel.

3.3 The light-weight aggregates shall be subjected to each test shown in 4.1 to 4.8, and the results shall conform to the requirements of Table 6.

Table 6. Qualities

Test item	Artificial light-weight aggregates	Natural light-weight aggregates By-product light-weight aggregates
Ignition loss	1% max.	5% max.
Sulfur trioxide (as SO_3)	0.5% max.	0.5% max.
Chlorides (as NaCl)	0.01% max.	0.01% max.
Calcium oxide (as CaO) (2)	-	50% max.
Organic impurities	Colour of test solution shall not be darker than that of the standard colour solution.	
Stability (3)	-	20% max.
Clay lumps	1% max.	2% max.

Notes (2) This is applied only to the expanded slags and processed products thereof.

(3) In the case when the aggregates are used for a concrete which is particularly required of resistivity to freezing and melting, the resistivity to freezing and melting of the concrete in which the aggregates are used shall be confirmed.

3.4 Grain Sizes

3.4.1 Grain Sizes The grain sizes of light-weight aggregates shall be subjected to the test shown in 4.9, and the size ranges shall be in the ranges of Table 7 for the coarse aggregates and of Table 8 for the fine aggregates.

Table 7. Percentages in Mass of Coarse Aggregates Passing through Sieves

Unit: %

Classification of aggregates	Size of aggregates (mm)	Nominal size of sieve (4) (mm)				
		25	20	15	10	5
Artificial light-weight aggregates	20 to 5	100	90 to 100	-	20 to 55	0 to 10
	15 to 5	-	100	90 to 100	40 to 70	0 to 15
Natural light-weight aggregates and by-product light-weight aggregates	20 to 5	100	90 to 100	-	20 to 75	0 to 15

Table 8. Percentage in Mass of Fine Aggregates Passing through Sieves

Unit : %

Classification of aggregates	Nominal sizes of sieves (4) (mm)							Percentage of loss in washing analysis (5)
	10	5	2.5	1.2	0.6	0.3	0.15	
Artificial light-weight aggregates	100	90 to 100	75 to 100	50 to 90	25 to 65	15 to 40	5 to 20	0 to 10
Natural light-weight aggregates and by-product light-weight aggregates	100	90 to 100	-	-	-	15 to 40	-	0 to 10

Notes (4) Every sieve of 25 mm, 20 mm, 15 mm, 10 mm, 5 mm, 2.5 mm, 1.2 mm, 0.6 mm, 0.3 mm and 0.15 mm corresponds respectively to 25.4 mm, 19.1 mm, 15.9 mm, 9.52 mm, 4760 μm, 2380 μm, 1190 μm, 590 μm, 297 μm and 149 μm of the standard wire sieves specified in JIS Z 8801.

(5) The washing analyses are carried out in accordance with JIS A 1103.

3.4.2 Fineness Modulus The fineness modulus of artificial light-weight aggregates shall not deviate by ±0.3 or more for coarse aggregates and by ±0.15 or more for fine aggregates from fineness modulus obtained from the testings on the samples presented by the producer at the time of purchase.

4. Tests

4.1 Sampling Method As the samples, those which are representative shall be taken.

4.2 Ignition Loss About 500g of sample which has been dried until its mass becomes constant at 100 to 110°C is pulverized, and is adjusted for use. The testing method shall be in accordance with 6.1 of JIS R 5202.

4.3 Sulfur Trioxide About 500g of sample which has been dried until its mass becomes constant at 100 to 110°C is pulverized, and is adjusted for use. The testing method shall be in accordance with 6.8 of JIS R 5202.

4.4 Calcium Oxide About 500g of sample which has been dried until its mass becomes constant at 100 to 110°C is pulverized, and is adjusted for use. The testing method shall be in accordance with 6.6 of JIS R 5202.

4.5 Chlorides

4.5.1 Apparatus The apparatus to be used for analyses shall consist of a wide-mouthed bottle with ground stopper, 2 pipettes (each of 1 ml and 5 ml), a burette (25 ml), a Erlenmeyer flask (300 ml) and one set of balance (measurable to 1g for weighing capacity of 2 kg).

4.5.2 Reagents As the reagents, potassium chromate indicator (5 w/v %) and N/10 silver nitrate solution shall be used.

4.5.3 Procedures Weigh out a sample of 500g and put it into a wide-mouthed bottle; dry it until its mass becomes constant at 100 to 110°C and obtain the absolute dry mass W (g) of the sample. Pour 500 ml of purified water (6) as it stands onto the sample in the wide-mouthed bottle and leave them standing for 24 hours while being covered. Thereafter, repeat three times of upside-down shaking at about five minute interval to extract chlorides. Leave it standing for a while and take 50 ml of supernatant liquid (7) into the Erlenmeyer flask by the pipette. Add 1 ml of potassium chromate indicator to it and carry out titration with N/10 silver nitrate solution. Regard the time when its red colour becomes unextinguishable, even if it has been mixed by shaking as the end point, assume the consumption at that time as A (ml).

Notes (6) Distilled water or purified water with ion exchange resin.

(7) The supernatant liquid is filtrated using the filter paper of Class 5-B of JIS P 3801, if necessary.

4.5.4 Calculation of Results The chlorides shall be expressed by percentage in mass as NaCl, and be given from the following equation:

$$\text{Chlorides (as NaCl) (\%)} = \frac{0.00584 \times A \times 10}{W} \times 100$$

4.6 Organic Impurities The organic impurities shall be tested by the method in accordance with JIS A 1105.

In the testing of the coarse aggregates, the sample shall all be so pulverized as to pass through 5 mm sieve.

4.7 Stability The stability shall be tested by the method in accordance with JIS A 1122. The procedure shall be made five times in this test.

4.8 Clay Lumps The clay lumps shall be tested by the method in accordance with JIS A 1137.

Minimum mass of the sample shall be 1/2 the mass of sample designated in JIS A 1137.

4.9 Grain Sizes The grain sizes shall be tested by the methods in accordance with JIS A 1102 and JIS A 1103.

Minimum mass of the sample to be used in the washing test of the aggregates shall be 1/2 the standard mass of sample designated in JIS A 1103.

4.10 Absolute Dry Specific Gravities The absolute dry specific gravities shall be tested by the methods in accordance with JIS A 1134 and JIS A 1135.

4.11 Solid Content of Fine Aggregates in Mortar

4.11.1 Samples The samples to be used in one testing shall generally be 0.200 l of Portland cement in absolute volume and 0.600 l of fine aggregates with surface dry condition.

(24-hour absorption). In order to make the fine aggregates present surface dry condition (24-hour absorption), 3.1, 3.2 and 3.3 of JIS A 1134 shall be applied.

4.11.2 Test Apparatus A vessel of metallic cylinder, 82 mm inside diameter and 95 mm height, shall be used. Inside volume of the vessel shall be measured correctly to 1 ml. The stamping bar shall be of round steel bar, 9 mm in diameter and 25 cm in length, and its end be made hemispherical shape.

4.11.3 Mixing of Motar and Determination of Amount of Water Correctly measure the cement and fine aggregates designated in 4.11.1 to 1g and put them into a bowl; after two minutes of mixing, add water again and mix for three minutes.

Immediately measure the flows two times in order to determine the amount of water so as to make the average of two times as 180 ± 5.

The bowl and spoon to be used for mixing shall be in accordance with 7.1.2 of JIS R 5201. The flow test shall be in accordance with 9.7 of JIS R 5201.

4.11.4 Measurements for Mass of Unit Volume of Mortar Mix the mortar by the method of 4.11.3 and immediately pack it in a vessel. Calculate the mass of unit volume from 4.11.5, measuring the mass of mortar in the vessel correctly to 1g. At the same time, measure, one time, the flow.

Pack the mortar, separating into two layers, in the vessel. Lightly tap the side face of the vessel after stamping 25 times each layer by the stamping bar.

Complete the mixing and measurement within 10 minutes. Carry out the above measurements on three batches of mortar.

4.11.5 Calculation of Results The calculation of the results shall be made separately on each batch measured in accordance with 4.11.4 as follows:

Mass of unit volume w of mortar is calculated to 0.001 kg/l from the following equation:

$$w\ (\mathrm{kg}/l) = \frac{\text{Mass of mortar in the vessel (g)}}{\text{Inside volume of the vessel (ml)}}$$

Mixed up volume of mortar in one batch is calculated to 1 ml from the following equation:

$$v\ (\mathrm{ml}) = \frac{\text{Sum of measured masses of cement, fine aggregates and water (g)}}{w\ (\mathrm{kg}/l)} \times 100$$

Solid content p of fine aggregates in mortar is calculated to 0.1% from the following equation:

$$p\ (\%) = \frac{600\ (\mathrm{ml})}{v\ (\mathrm{ml})} \times 100$$

Mass of unit volume of mortar and solid content of fine aggregates are given by the mean value of three tests.

Reference Unit amount of water W in mortar can be calculated from the following equation:

$$W\ (kg/m^3) = \frac{\text{Measured amount of water (g)}}{v\ (ml)} \times 1000$$

4.11.6 Accuracy The difference between the maximum value and minimum value of solid content (%) of the fine aggregates given from three batches of mortar shall be not more than 0.5.

4.12 Solid Contents of Coarse Aggregates

4.12.1 The coarse aggregates shall be screened by the sieves of 5 mm, 10 mm and 20 mm and be dried at 100 to 110°C until these become constant in mass. Representative samples of 10 to 5 mm and 20 to 10 mm, of which amounts are shown in Table 9, are taken and these shall be mixed thoroughly and be served as the test samples for one test.

Table 9

Size of aggregates mm	Mass of samples for one test g	
	Test for specific gravity	Test for mass of unit volume
10 to 5	1000	6000
20 to 10	1000	6000

4.12.2 The absolute dry specific gravity of the coarse aggregates shall be given in accordance with JIS A 1135.

4.12.3 The mass of unit volume of the coarse aggregates shall be given in accordance with JIS A 1104.

4.12,4 Calculation of the solid content of the coarse aggregates shall be carried out from the following equation:

$$\text{Solid content (\%)} = \frac{\text{Mass of unit volume (kg/l)}}{\text{Absolute dry specific gravity}} \times 100$$

4.13 Compressive Strength and Mass of Unit Volume as Concrete

4.13.1 The compressive strength of the light-weight aggregates as concrete shall be designated by the compressive strength of 28-day age concrete of which materials and mix proportion are as shown in the following. The mass of unit volume shall be designated by that of the fresh concrete of the same mix proportion.

4.13.2 In testing the artificial light-weight coarse aggregates, the artificial light-weight fine aggregates or river sands shall be used as fine aggregates; in testing the natural light-weight coarse aggregates and by-product light-weight coarse aggregates, the river sands shall be used as fine aggregates.

In testing the artificial light-weight fine aggregates, the artificial light-weight coarse aggregates shall be used as coarse aggregates; in testing the natural light-weight fine aggregates and by-product light-weight fine aggregates, the natural light-weight coarse aggregates and by-product light-weight coarse aggregates shall be used respectively.

4.13.3 Mix proportion of the concrete shall be taken as the water-cement ratio 40% and the slump 8 ± 1 cm. The sand percentage shall be so determined as to secure the plasticity of concrete (8). Neither AE agent nor dispersing agent shall be used for the concrete.

Note (8) In general, the sand percentage may be taken as 40%

4.13.4 The cement to be used shall conform to the requirements of JIS R 5210 and shall be of ordinary Portland cement providing 400 ± 30 kgf/cm^2 [39.2 ± 2.9 MPa] of four-week compressive strength in accordance with 9. of JIS R 5201.

4.13.5 The light-weight aggregates used shall be of the dry surface condition (24-hour absorption).

4.13.6 In using the river sands as the fine aggregates, these shall be clean, tough and durable and the grain sizes shall be those which fall in the ranges of Table 10.

The fine aggregates used shall be those which are in saturated surface-dried condition.

Table 10

Nominal size of sieve mm	10	5	2.5	1.2	0.6	0.3	0.15
Mass percentage of fine aggregates that passes through sieve	100	90 to 100	80 to 100	50 to 90	25 to 65	10 to 35	2 to 10

4.13.7 The compressive strength test of the concrete shall be carried out in accordance with JIS A 1132 and JIS A 1108.

4.13.8 The test for mass of unit volume of the concrete shall be carried out in accordance with JIS A 1116.

5. Marking

The invoice or test result table of the light-weight aggregates shall be marked with the following information:

(1) Classification shown in 2. ([9])

(2) Place of production or manufacturer's name

Note ([9]) Mix proportion of the concrete, combination of fine and coarse aggregates and strength of cement used therein when the compressive strength as concrete and classification by mass of unit volume are determined, are additionally described.

Applicable Standards:

JIS A 1102-Method of Test for Sieve Analysis of Aggregate

JIS A 1103-Method of Test for Amount of Material Passing Standard Sieve 74 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 1108-Method of Test for Compressive Strength of Concrete

JIS A 1116-Method of Test for Unit Weight and Air Content (Gravimetric) of Fresh Concrete

JIS A 1122-Method of Test for Soundness of Aggregate by Use of Sodium Sulfate

JIS A 1132-Method of Making and Curing Concrete Specimens

JIS A 1134-Method of Test for Bulk Specific Gravity and Absorption of Light Weight Fine Aggregate for Structural Concrete

JIS A 1135-Method of Test for Bulk Specific Gravity and Absorption of Light Weight Coarse Aggregate for Structural Concrete

JIS A 1137-Method of Test for Clay Contained in Aggregate

JIS P 3801-Filter Paper (for Chemical Analysis)

JIS R 5201-Physical Testing Methods of Cement

JIS R 5202-Method for Chemical Analysis of Portland Cement

JIS R 5210-Portland Cement

JIS Z 8801-Sieves for Testing Purposes

(A 16) UDC 666.972.12:691.322

JAPANESE INDUSTRIAL STANDARD J I S

Crushed Stone for Concrete A 5005-1987

1. Scope

This Japanese Industrial Standard specifies the crushed stone for concrete produced in a factory, hereinafter referred to as the "crushed stone".

2. Manufacture

2.1 The raw stone of crushed stone shall be basalt, andesite, hard sand stone, hard limestone or rock having a stone quality similar to these.

2.2 The following raw stones shall not be used: the raw stones producing flat form when crushed, such as schist, gneiss, clay stone, etc., weak raw stones, such as soft sand stone, soft tuff, weathered rock, etc., and raw stones liable to incur intercrystalline to cracks when crushed.

3. Classification

Classification of the crushed stone according to grain size shall be as given Table 1 and according to alkali-silica reaction as given in Table 2.

Table 1. Class According to Grain Size

Class	Range of grain size mm
Crushed stone 5005	50 to 5
Crushed stone 4005	40 to 5
Crushed stone 2505	25 to 5
Crushed stone 2005	20 to 5
Crushed stone 1505	15 to 5
Crushed stone 8040	80 to 40
Crushed stone 6040	60 to 40
Crushed stone 5025	50 to 25
Crushed stone 4020	40 to 20

Applicable Standards: See page 6.

Table 2. Class According to Alkali-Silica Reaction

Class	Remark
A	Judged as harmless by the result on alkali-silica reaction test.
B	Not judged as harmless by the result of alkali-silica reaction test or not tested yet.

4. Quality

4.1 The crushed stone shall be clean, rigid and durable, and be free from a harmful amount of dust, mud, organic impurities, etc.

4.2 The quality of crushed stone shall be tested in accordance with 5.2 to 5.5, and the results shall comply with the requirements of Table 3.

Table 3. Quality

Test item	Standardized value
Absolute dry specific gravity	2.5 min.
Percentage of water absorption	3 % max.
Soundness	12 % max.
Abraded quantity	40 % max.
Amount lost in washing test	1.0 % max.

4.3 The crushed stone classified as Class A shall be that judged as harmless by the result of alkali-silica reaction test in accordance with 5.8.

4.4 Grain size of the crushed stone shall come within the range given in Table 4 when tested according to 5.6.

Table 4. Grain Size

Class \ Nominal size of sieve (1) mm	Mass percentage (%) of undersizes										
	100	80	60	50	40	25	20	15	10	5	2.5
Crushed stone 5005	—	—	100	95 to 100	—	35 to 70	—	10 to 30	—	0 to 5	—
Crushed stone 4005	—	—	—	100	95 to 100	—	35 to 70	—	10 to 30	0 to 5	—
Crushed stone 2505	—	—	—	—	100	95 to 100	—	30 to 70	—	0 to 10	0 to 5
Crushed stone 2005	—	—	—	—	—	100	90 to 100	—	20 to 55	0 to 10	0 to 5
Crushed stone 1505	—	—	—	—	—	—	100	90 to 100	40 to 70	0 to 15	0 to 15
Crushed stone 8040	100	90 to 100	45 to 70	—	0 to 15	—	0 to 5	—	—	—	—
Crushed stone 6040	—	100	90 to 100	35 to 70	0 to 15	—	0 to 5	—	—	—	—
Crushed stone 5025	—	—	100	90 to 100	35 to 70	0 to 15	—	0 to 5	—	—	—
Crushed stone 4020	—	—	—	100	90 to 100	20 to 55	0 to 15	—	0 to 5	—	—

Note (1) These sieves respectively correspond to 106 mm, 75 mm, 63 mm, 53mm, 37.5 mm, 26.5 mm, 19 mm, 16 mm, 9.5 mm, 4.75 mm and 2.36 mm of standard sieves specified in JIS Z 8801.

4.5 Grain Form

4.5.1 The crushed stone shall be free from a harmful amount of thin or slender stone pieces.

4.5.2 As for the crushed stone 2005, it shall be tested in accordance with 5.7 to have a value not less than 55 %.

5. Test Method

5.1 Sampling A sample representative of the product shall be taken from a stock in a transporting conveyer and a store bin, or from a stock pile while the stone is manufactured under crushing process, and then it shall be rationally reduced.

5.2 Absolute Dry Specific Gravity and Water Absorption Percentage Absolute dry specific gravity and water absorption percentage shall be tested in accordance with JIS A 1110.

5.3 Soundness Test Soundness test shall be carried out in accordance with JIS A 1122. The number of tests should be five.

5.4 Abrasion Test Abrasion test shall be carried out in accordance with JIS A 1121.

5.5 Washing Test The amount lost in washing test shall be tested in accordance with JIS A 1103.

5.6 Grain Size Test The grain size test shall be carried out in accordance with JIS A 1102.

5.7 Test for Absolute Volume Percentage for Assessment of Grain Shape The test for percentage of absolute volume for judgment of grain form shall be as follows:

(1) The method preparing of sample shall be as follows: screen the crushed stone, which has been dried in absolutely-dried state, into 24 kg of grains with size of 20 mm to 10 mm and 16 kg of grains with size of 10 mm to 5 mm, and mix them sufficiently.

(2) Obtain the unit weight T (kg/l) of sample in accordance with the method specified in JIS A 1104.

(3) As density D_0 (absolute dry specific gravity) of the sample, use the value obtained at 5.2.

(4) Obtain the percentage of absolute volume for judgment of grain form from the following formula:

$$\text{Percentage of absolute volume for judgment of grain form} \quad \% \quad \frac{T}{D_0} \times 100$$

5.8 Alkali-Silica Reaction Test Carry out the alkali-silica reaction test in accordance with the description in Appendix 7 [Alkali-silica reaction test method on aggregate (chemical method)] or Appendix 8 [Alakli-silica reaction test method on aggregate (mortar bar method)] of JIS A 5308. Provided the stopes are common, however, the test result for crushed stone 2005 shall be used for other classes of crushed stone.

6. Inspection

Inspection shall be carried out as follows: determine the lot size in accordance with JIS Z 9001 or agreement between the parties concerned, take out the sample in accordance with a reasonable sampling inspection method and put it to a test in accordance with 5.; and if the sample taken from the lot has satisfied the specification of 4., the lot shall be judged as acceptable.

7. Marking

On the invoice of the crushed stone for concrete, the following items shall be marked.

(1) Name and class (Example: Crushed stone for concrete 2005 A)

(2) Name of manufacturer and name and number of digging site

(3) Year, month, and day of shipping

(4) Mass or volume

(5) Name of recipient factory

8. Report

Manufacturer should submit a test report to the purchaser when required. Standard form of the test report shall conform to Table 5.

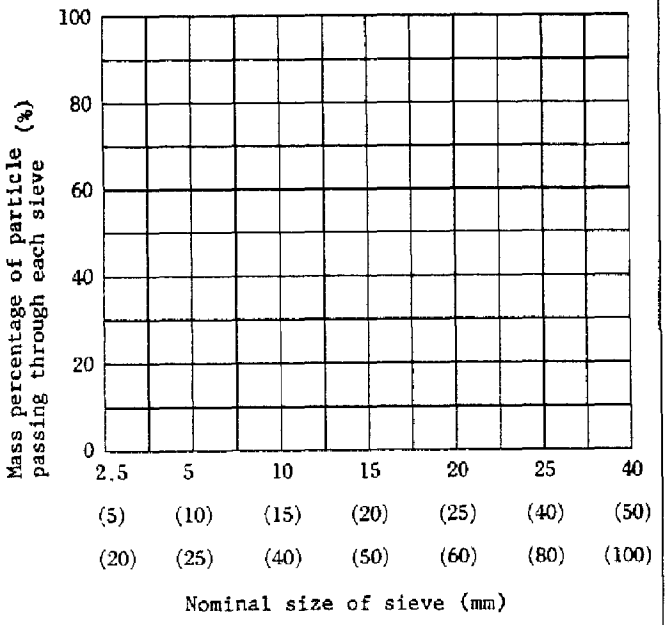
Table 5. Standard Form of Test Report

Test Report of Crushed Stone for Concrete

Class		Kind of raw stone	
Name of manufacturer		Name and number of digging site	
Name of factory		Date of test	Physical test: Alkali-silica reaction test:

Test items (Physical test)	Standardized value	Test value	Remark
Absolute dry specific gravity (JIS A 1110)	2.5 min.		Specific gravity in saturated surface ( ) dry condition
Water absorption test (JIS A 1110)	3 % max.		
Soundness test (JIS A 1122)	12 % max.		
Abraded quantity (JIS A 1121)	40 % max.		
Amount lost in washing test (JIS A 1103)	10 % max.		
Absolute volume percentage for assessment of grain shape (JIS A 5005)	55 % min.		For only crushed stone 2005

	Nominal size of sieve	Mass percentage of particles passing through each thieve (%)
Sieve analysis test	100	
	80	
	60	
	50	
	40	
	25	
	20	
	15	
	10	
	5	
	2.5	
f.m.		



Alkali-silica reaction test (JIS A 5308)	Test result*	
	Test method	

* A: Judged as harmless B: Not judged as harmless or not tested yet.

Name of testing organization	Physical test:
	Alkali-silica reaction test:
Transferer from original text	Name of manufacturer:
	Name of person in charge:

Applicable Standards:

JIS A 1102-Method of Test for Sieve Analysis of Aggregate

JIS A 1103-Method of Test for Amount of Material Passing Standard Sieve 74 μm in Aggregates

JIS A 1104-Method of Test for Unit Weight of Aggregate and Solid Content in Aggregate

JIS A 1110-Method of Test for Specific Gravity and Absorption of Coarse Aggregate

JIS A 1121-Method of Test for Abrasion of Coarse Aggregate by Use of the Los Angeles Machine

JIS A 1122-Method of Test for Soundness of Aggregate by Use of Sodium Sulfate

JIS A 5308-Ready-Mixed Concrete

JIS Z 8801-Test Sieves

JIS Z 9001-General Rules for Sampling Inspection Procedures

TITULOS PUBLICADOS

BASES DE DATOS PARA LA ESTIMACION DE RIESGO SISMICO EN LA CIUDAD DE MEXICO; Coordinación de Investigación, Area de Riesgos Geológicos; M. Ordaz, R. Meli, C. Montoya-Dulché, L. Sánchez y L.E. Pérez-Rocha.

TRANSPORTE, DESTINO Y TOXICIDAD DE CONSTITUYENTES QUE HACEN PELIGROSO A UN RESIDUO; Coordinación de Investigación; Area de Riesgos Químicos; Ma. E. Arcos, J. Becerril, M. Espíndola, G. Fernández y Ma. E. Navarrete.

PROCESOS FISICOQUIMICOS PARA ESTABILIZACION DE RESIDUOS PELIGROSOS; Coordinación de Investigación; Area de Riesgos Químicos; M. Y. Espíndola y G. Fernández

REFLEXIONES SOBRE LAS INUNDACIONES EN MEXICO; Coordinación de Investigación; Area de Riesgos Hidrometeorológicos; R. Domínguez, M. Jiménez, F. García y M.A. Salas.

MODELO LLUVIA-ESCURRIMIENTO; Coordinación de Investigación; Area de Riesgos Hidrometeorológicos; R. Domínguez, M. Jiménez, F. García y M.A. Salas

REPORT ON THE JANUARY 17, 1994 NORTHRIGDE EARTHQUAKE. SEISMOLOGICAL AND ENGINEERING ASPECTS; Coordinación de Investigación; Areas de Riesgos Geológicos y de Ensayes Sísmicos; T. Mikumo, C. Gutiérrez, K. Kikuchi, S. M. Alcocer y T. A. Sánchez.

APPLICATION OF FEM (FINITE ELEMENT METHOD) TO RC (REINFORCED CONCRETE) STRUCTURES, Coordinación de Investigación; Area de Ensayes Sísmicos, H. Noguchi.

DEVELOPMENT OF ADVANCED REINFORCED CONCRETE BUILDINGS USING HIGH-STRENGTH CONCRETE AND REINFORCEMENT -NEW CONSTRUCTION TECHNOLOGY IN JAPAN-; Coordinación de Investigación, Area de Ensayes Sísmicos; S. Otani.

A STUDY ON NONLINEAR FINITE ELEMENT ANALYSIS OF CONFINED MASONRY WALLS; Coordinación de Investigación; Area de Ensayes Sísmicos; K Ishibashi; H Kastumata; K. Naganuma; M. Ohkubo.

SEGURIDAD SISMICA DE LA VIVIENDA ECONOMICA; Coordinación de Investigación; Area de Ensayes Sísmicos; R. Meli; S M. Alcocer; L.A. Díaz Infante; T.A. Sánchez; L.E. Flores; R. Vázquez del Mercado; R R. Díaz.

DETERMINISTIC INVERSE APPROACHES FOR NEAR-SOURCE HIGH-FRECUENCY STRONG MOTION; Coordinación de Investigación, Area de Riesgos Geológicos, M. Iida.

SISMICIDAD Y MOVIMIENTOS FUERTES EN MEXICO: UNA VISION ACTUAL; Coordinación de Investigación; Area de Riesgos Geológicos; S K. Singh, M. Ordaz.

JAPANESE PRESSS DESIGN GUIDELINES FOR REINFORCED CONCRETE BUILDINGS; Coordinación de Investigación; Area de Ensayes Sísmicos, S. Otani.

COMENTARIOS SOBRE LAS NORMAS INDUSTRIALES JAPONESAS DE LA CALIDAD DE AGREGADOS PARA EL CONCRETO, Coordinación de Investigación; Area de Ensayes Sísmicos; M. Saito, H. Kitajima, K. Suzuki, S. M. Alcocer

COMENTARIOS SOBRE LAS NORMAS INDUSTRIALES JAPONESAS DE LA CALIDAD DEL CONCRETO; Coordinación de Investigación, Area de Ensayes Sísmicos; M. Saito, H. Kitajima, K. Suzuki, S. M. Alcocer.

NORMAS DE DISEÑO PARA ESTRUCTURAS DE MAMPOSTERIA DEL INSTITUTO DE ARQUITECTURA DEL JAPON, Coordinación de Investigación, Area de Ensayes Sísmicos; K Yoshimura, K Kikuchi, T A. Sánchez.