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JAPANESE INDUSTRIAL STANDARD J I S

Method of Test for Soundness of Aggregates by Use of Sodium Sulfate

A 1122-1989

1. Scope

This Japanese Industrial Standard specifies the method of test for the soundness of aggregates based on their resistance to the breaking action through crystallization pressures of sodium sulfate. However, artificial lightweight aggregates shall be excluded.

2. Test Appliances

2.1 The sieves to serve shall be as follows.

In the test of fine aggregates: Wire sieves of 0.15, 0.3, 0.6, 1.2, 2.5, 5 and 10 mm in size ([1]).

In the test of coarse aggregates: Wire sieves of 5, 10, 15, 20, 25, 30, 40, 50, 60 and 80 mm in size ([2]).

Notes ([1]) These wire sieves shall be respectively the standard sieves 150, 300 and 600 μm, 1.18, 2.36, 4.75 and 9.5 mm in size specified in JIS Z 8801.

([2]) These wire sieves shall be respectively the standard sieves 4.75, 9.5, 16, 19, 26.5, 31.5, 37.5, 53, 63 and 75 mm in size specified in JIS Z 8801.

Applicable Standards:

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

JIS K 8155-Barium Chloride

JIS K 8986-Sodium Sulfate

JIS K 8987-Sodium Sulfate, Anhydrous

JIS Z 8401-Rules for Rounding off of Numerical Values

JIS Z 8801-Test Sieves

Reference Standards:

JIS A 5002-Light Weight Aggregates for Structural concrete

JIS A 5005-Crushed Stone for Concrete

2.2 The wire net cage ([3]) to hold the aggregates in shall not be corroded by the test solution specified in 3. and its aperture size shall be sufficiently small to prevent the aggregate particles from passing through.

Note ([3]) As an alternative, a container having holes drilled on the side, bottom, or the like for draining the test solution adhering to the aggregates may be used.

2.3 The container used for immersing the aggregates in the test solution shall not be corroded by the solution and capable of the operation of 5.2.

2.4 The balance used for testing fine aggregates shall have a weighing capacity of not less than 500 g and a reciprocal sensibility of within 0.1 g, and the balance for testing coarse aggregates shall have a weighing capacity of not less than 5 kg and a reciprocal sensibility of within 1 g.

2.5 The drier to serve shall be capable of maintaining the temperature at 100 to 110°C ([4]).

Note ([4]) Use of a drier equipped with an air stirrer and a ventilator is preferable.

3. Test Solution

3.1 The test solution shall be a saturated sodium sulfate solution prepared as follows: add about 350 g of sodium sulfate (anhydrous) ([5]) (Na_2So_4) or about 750 g of sodium sulfate (crystalline) ([6]) ($Na_2So_410H_2O$) to 1 l of clean water kept at 25 to 30°C, dissolve by stirring well and cool to about 20°C. Maintain the solution at 20 ± 1°C for 48 h or longer before it is used for the test. When it is to be used for the test, there shall be formed crystals present on the container bottom ([7]).

Notes ([5]) Guaranteed grade sodium sulfate (anhydrous) specified in JIS K 8987 shall be used.

([6]) Guaranteed grade sodium sulfate (reagent) specified in JIS K 8986 shall be used.

([7]) The specific gravity of the solution when used for the test shall be 1.151 to 1.174 (Baumé degree, 18.9 to 21.4)

3.2 The concentration of barium chloride ([8]) ($BaCl_2$) solution for examining whether or not the test solution remains on the aggregates shall be 5 to 10 %.

Note ([8]) Guaranteed grade barium chloride (reagent) specified in JIS K 8155 shall be used.

4. Sample

4.1 For Test of Fine Aggregates ([9])

(1) Take about 2 kg of sample which is representative of the aggregates.

(2) Perform a sieve analysis test using part of the sample in accordance with JIS A 1102. Divide the sample into the groups based on the particle size shown in Table 1, obtain the percentages of the individual groups, and then carry out the soundness test for only the groups whose percentages are 5 % or more.

Tale 1

Particle size ranges of groups classified by nominal sieve size mm
To pass 0.6 and remain on 0.3
To pass 1.2 and remain on 0.6
To pass 2.5 and remain on 1.2
To pass 5 and remain on 2.5
To pass 10 and remain on 5.

(3) While adequately washing with water the remainder of the sample after the sample for the sieve analysis test is taken, screen with the 0.3 mm wire sieve, take the particles remaining on the wire sieve, dry at 100 to 110°C until a constant mass is obtained, further sift them out, weigh out a quantity of 100 g ([10]) from each of the groups specified in (2) and reserve separately for use as the sample of each group ([11]).

Notes ([9]) Those particles remaining on the 10 mm sieve shall not be treated as fine aggregates.

([10]) It is recommended to take at first about 110 g by rough screening, further screen it elaborately, and weigh out 100 g of sample.

([11]) The particles caught in the apertures shall not be mixed with the sample.

4.2 For Test of Coarse Aggregates

(1) The sample taken shall be representative of the coarse aggregates and its mass shall have the value specified in Table 2 as the standard according to the maximum size of the aggregates. However, in the case of lightweight aggregates, 1/2 of the above mass shall be taken as standard.

Table 2

Maximum size of aggregates mm	Mass of sample taken ([12]) kg
10	1
15	2.5
20	5
25	10
40	15
60	25
80	30

Note ([12]) Where this quantity cannot be taken, it shall be confirmed that the sample taken is representative of the aggregates.

(2) Screen the sample with a 5 mm wire sieve, perform a sieve analysis test in accordance with JIS A 1102 for the particles remaining on the sieve, divide the particles into the groups by the particle sizes shown in Table 3, calculate the percentages of the respective groups and then perform the soundness test for the groups whose percentages are 5 % or more.

(3) Adequately wash the coarse aggregates with water, dry at 100 to 110°C until a constant mass is obtained, weigh out the quantities specified in Table 3 from the respective groups and reserve separately as the samples of the respective groups ([11]). The number of particles 20 mm or over shall be ascertained for each group.

Table 3

Particle size ranges of groups classified by nominal sieve size mm	Minimum mass of sample ([13]) g
To pass 10 and remain on 5	300
To pass 15 and remain on 10	500
To pass 20 and remain on 15	750
To pass 25 and remain on 20	1000
To pass 40 and remain on 25	1500
To pass 60 and remain on 40	3000
To pass 80 and remain on 60	3000

Note ([13]) In the case of lightweight agregates, 1/2 of the mass shown in the table shall be adopted.

4.3 For Test of Rock When testing a rock, preferably crush a rock into particles of the same shape and size each with a mass of about 100 g. Wash the crushed particles, dry at 100 to 110°C until a constant mass is obtained, and then take 5000 ± 100 g of the particles as the sample.

5. Test Method

5.1 The test solution shall be stirred frequency before used for the test.

5.2 Place the sample in a wire net cage and immerse in the test solution ([14]). In this operation, the surface of the solution shall be positioned 15 mm or more above the upper surface of the sample ([15]).

A suitable cover shall be attached to prevent the evaporation of the solution and the admixing of foreign matters. The temperature of the solution shall be maintained at 20 ± 1°C.

The time duration of immersing the sample in the solution shall be 16 to 18 h.

Notes ([14]) Care should be taken not to spill the sample during these operations.

([15]) In the case of lightweight aggregates for structural use, it is recommended to place a metal sieve of suitable mass on top of the sample.

5.3 After withdrawing the sample from the solution and confirming that the solution has stopped dripping ([16]), place the sample in the drier and, raising the temperature in the drier at a rate of about 40°C per hour, dry ([15]) the sample at 100 to 110°C for 4 to 6 h ([17]).

Notes ([16]) Particles 20 mm or larger shall then be closely observed for their breaking condition.

([17]) It is not proper to continue drying the sample for a longer time than required.

5.4 Cool the dried sample to room temperature.

5.5 The operations of 5.2 to 5.4 shall be repeated ([19]) the specified number of times ([18]).

Notes ([18]) Refer to Informative Reference.

([19]) The solution shall not be reused 10 or more times.

5.6 Wash with clean water ([20]) the sample through with the specified number of operations. Continue the washing until the washing water is no more clouded when a small amount of barium chloride ($BaCl_2$) solution is added to it. Dry the washed sample at 100 to 110°C until a constant weight is obtained.

Notes ([20]) The sample may be boiled where required.

5.7 In the case of fine aggregates or coarse aggregates, prior to the test, screen the dried sample of each group with the sieve on which the sample has remained, and weigh the mass of the sample remaining on the sieve. The particles 20 mm or over in size shall be closely observed for the condition of breakage (crumbling, cracking, scaling off, crazing and the like).

5.8 In the case of rock, lightly press the sample with fingers and ascertain the number of sample particles broken into 3 or more pieces.

In addition, closely observe the particles for the condition of breakage (crumbling, cracking, scaling off, crazing and the like.)

6. Calculation of Result

6.1 The mass loss percentage (P_1) of the sample of each group shall be calculated from the following formula and rounded to the first decimal place in accordance with JIS Z 8401.

$$P_1 = \left(1 - \frac{m_2}{m_1}\right) \times 100$$

where P_1: mass loss percentage of aggregates (%)

m_1: mass of sample before test (g)

m_2: mass of sample remaining after test on the sieve on which the sample has remained before test (g)

6.2 The mass loss percentage of the aggregates is the total sum of the products of the mass percentage of particles in the respective groups of the tested aggregates and the mass loss percentage in the respective groups. In this calculation, the mass loss percentages in the groups of the mass percentage of particles less than 5 % shall be represented by the average of those of the immediately preceding and succeeding groups obtained. Where the test value of either the immediately preceding or the succeeding group is lacking, the mass loss percentage furnished shall be adopted.

The calculation shall be made on the assumption that the mass loss percentage of the particles passing the 0.3 mm wire sieve is zero.

6.3 The mass loss percentage (P_2) in the case of rock shall be calculated from the following formula and rounded off to the first decimal place in accordance with JIS Z 8401.

$$P_2 = \left(1 - \frac{m_4}{m_3}\right) \times 100$$

where P_2: mass loss percentage of rock (%)

m_3: mass of sample before test (g)

m_4: mass of particles with those broken into 3 or more pieces excluded (g)

7. Report

Information items required from among the following shall be included in the report:

(1) Kind, size, appearance, and locality of occurrence of aggregates or rock

(2) Sampling position and date and time

(3) Results of sieve analysis test of sample

(4) Mass of samples in respective groups before test

(5) Mass loss percentages of samples in respective groups

(6) Mass loss percentage of aggregates

(7) The number of particles larger than 20 mm before test, the number of particles in which abnormalities were observed, and conditions of their breakage.

(8) In the case of rock, the number of particles broken into 3 or more pieces, mass loss percentage, and conditions of breakage of particles

Informative References

(1) The results of this test will serve as a material for judging the soundness of aggregates against meteorological effects, especially as a useful reference where it is impossible to make survey on a suitable practical example.

(2) There are several prescriptions for the number of tests as listed below.

JIS A 5002:	5 times
JIS A 5005:	5 times
Standard Specification on Concrete by the Japan Society of Civil Engineers:	5 times
Japanese Architectural Standard Specification for Reinforced Concrete Work (JASS 5):	5 times

(3) Calculation examples of the mass loss percentage of samples from test results are shown as follows.

Examples for Reference

Sieve not passed mm	Sieve passed mm	Mass percentage of each group %	Mass of each group before test g	Mass loss percentage of each group %	Mass loss percentage of aggregates %
Soundness test for fine aggregates					
	0.15	5.0		- (1)	-
0.15	0.3	11.4		- (1)	-
0.3	0.6	26.0	100	4.2	1.1 (4)
0.6	1.2	25.2	100	4.8	1.2 (4)
1.2	2.5	17.0	100	8.0	1.4 (4)
2.5	5	10.8	100	11.2	1.2 (4)
5	10	4.6		11.2 (2)	0.5 (4)
Total		100.0	400		5.4
Soundness test for coarse aggregates					
5	10	22.0	300 (3)	11.2	2.5 (4)
10	15	23.0	500 (3)	9.6	2.2 (4)
15	20	35.0	750 (3)	8.0	2.8 (4)
20	25	20.0	1000 (3)	4.8	1.0 (4)
Total		100.0	2550		8.5

Notes (1) For particles smaller than 0.3 mm, the mass loss percentage is regarded as zero.

(2) The mass loss percentage of the group having the next smaller particle diameter is adopted.

(3) Although in this case the minimum quantity is taken, a larger quantity of sample may be taken.

(4) These values are calculated from the following formula:

$$\frac{\text{Mass percentage of each group} \times \text{Mass loss percentage of each group}}{100}$$

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JAPANESE INDUSTRIAL STANDARD J I S

Method of Test for Soft Particles in Coarse Aggregates by Use of Scratch Tester

A 1126-1989

1. Scope

This Japanese Industrial Standard specifies the test method for determining by means of scratch hardness the quantity of soft particles contained in coarse aggregates.

Remarks 1. The soft particles herein referred to means soft particles and fragile particles.

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.

2. Test Appliances

2.1 The brass rod used for the scratch hardness test shall have a hardness of HRB 65 to 75 when measured in accordance with JIS Z 2245 and a diameter of 1.6 mm ([1]).

Note ([1]) The brass rod can be used conveniently for the test when it is gripped in a thin pencil-like rod. The tip of the brass rod shall not particularly be sharpened.

2.2 The sieves to serve shall be 10, 15, 20, 25, 40 and 60 mm wire sieves ([2]).

Note ([2]) These sieves should respectively correspond to the standard sieves 9.5, 16, 19, 26.5, 37.5 and 63 mm in size specified in JIS Z 8801.

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

Applicable Standards:

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

JIS Z 2245-Method of Rockwell and Rockwell Superficial Hardness Test

JIS Z 8401-Rules for Rounding off of Numerical Values

JIS Z 8801-Test Sieves

3. Sample

The sample to serve shall be representative of the coarse aggregates, reduced either by the method of quartering or by the use of a sample splitter to the dry mass given in Table 1, and then removed of particles 10 mm or smaller in size.

Table 1

Maximum size of aggregates mm	Mass of sample to be taken kg
About 15	2.5
About 20	5
About 25	10
About 40	15
About 60	30

4. Test Method

4.1 The sample shall be subjected to a sieve analysis test specified in JIS A 1102 and divided into groups classified by the particle diameter as shown in Table 2. The percentages of the respective groups shall be obtained and only the groups of percentage 10 % or over shall be subjected to the scratch test.

The mass of the aggregates of respective groups to be tested shall be as specified in Table 2.

Table 2

Group	Mass of sample
Pass 15 mm and remain on 10 mm	200 g min.
Pass 20 mm and remain on 15 mm	700 g min.
Pass 25 mm and remain on 20 mm	1.5 kg min.
Pass 40 mm and remain on 25 mm	3 kg min.
Pass 60 mm and remain on 40 mm	6 kg min.

4.2 Scratch the sample particles of each group one by one with the brass rod by applying a force of about 1 kgf {9.8 N}. In this operation, single out the particles given scratch marks not accompanied by the color of brass and the particles with a portion chipped off ([3]) classifying them as the soft particles, and then obtain the total mass and the number of the soft particles for each group.

Note ([3]) In some sandstone-base aggregates, part of the sand particles scales off with the color of brass left on the remainder. Such particles shall be regarded as the soft particles.

5. Calculation of Results

5.1 The test results shall be calculated from the following formulas and rounded off to the first decimal place in accordance with JIS Z 8401.

$$P_w = \frac{m_2}{m_1} \times 100$$

$$P_N = \frac{N_2}{N_1} \times 100$$

$$P_2 = \Sigma \frac{P_1 \times P_w}{100}$$

where P_w: mass percentage of soft particles in individual group (%)

m_1: mass of individual group tested (g)

m_2: mass of soft particles in individual group (g)

P_1: mass percentage of individual group in sample (%)

P_2: mass percentage of soft particles in coarse aggregates (%)

P_N: number percentage of soft particles in individual group (%)

N_1: number of particles in individual group tested

N_2: number of soft particles in individual group

5.2 The test of 4. shall not be applied to the groups whose mass is less than 10 % of the total mass of the sample, and the averages of the values obtained for the preceding and succeeding groups shall be regarded as the values for such groups. Where either the preceding or the succeeding group is lacking, the values of the existing group shall be regarded as the values for the group whose mass is less than 10 % of the total mass.

6. Report

Information items in the following as considered necessary shall be included in the report.

(1) Kind, appearance, and locality of occurrence or name of the aggregates

(2) Sampling position and date and time

(3) Mass percentage of individual group tested

(4) Mass and number of particles of individual group tested

(5) Mass and number of soft particles in individual group

(6) Mass percentage and number percentage of soft particles in individual group

(7) Mass percentage of soft particles in coarse aggregates

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JAPNAESE INDUSTRIAL STANDARD J I S

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

A 1134-1989

1. Scope

This Japanese Industrial Standard Specifies the methods of test for bulk specific gravity and water absorption percentage of lightweight fine aggregates for structural concrete.

2. Test Appliances

2.1 The balance to serve shall have a weighing capacity not smaller than 2 kg and a reciprocal sensibility within 0.2 g.

2.2 The flow cone and tamping rod to serve shall be as specified in JIS A 1109.

2.3 The pycnometer to serve shall have a capacity not smaller than 700 ml. Figure shows an example of a suitable pycnometer.

Applicable Standards:

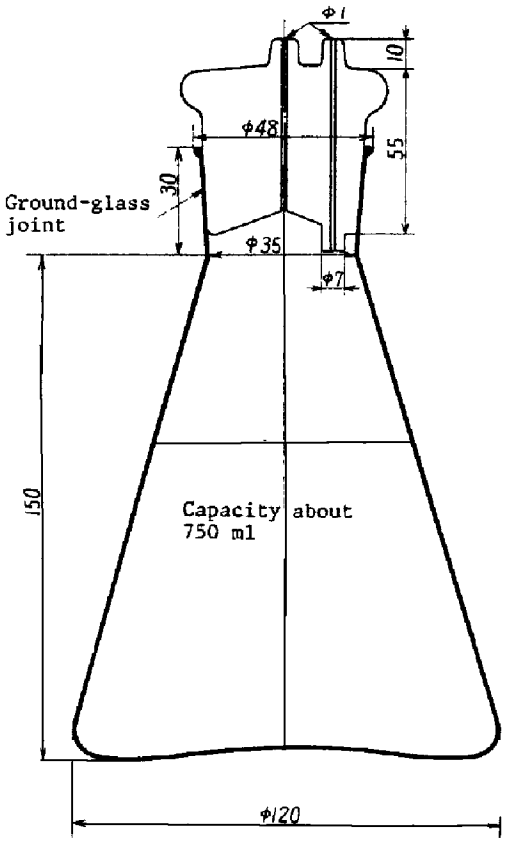
JIS A 1109-Method of Test for Specific Gravity and Absorption of Fine Aggregate

JIS R 5201-Physical Testing Methods of Cement

JIS Z 8401-Rules for Rounding off of Numerical Values

JIS Z 8801-Test Sieves

Figure



3. Sample

3.1 A representative sample of fine aggregates shall be taken in air-dried condition and reduced to about the required quantity by the method of quartering or by the use of a sample splitter. The required quantity shall be about 1600 g ([1]). This quantity shall further be divided into two equal parts of about 800 g with a sample splitter.

Note ([1]) This is the sum of the weights of sample needed for two test runs of either the specific gravity test or the water absorption percentage test.

3.2 Dry the sample of 3.1 at 100 to 100°C until a constant weight is obtained.

3.3 Cool the sample ([2]) of 3.2 to room temperature, allow to absorb water for 24 h or longer in still water at 15 to 25°C, and dry uniformly. When the surface of the fine aggregates still appears to retain some surface water, pack the fine aggregates loosely in the flow cone ([3]), and level the upper surface of the fine aggregates by lightly tapping ([4]) the flow cone at about 1/3 of its height with the end of a tamping rod 10 times each from 4 directions. Then, remove the flow cone by quietly pulling it up vertically.

The above operation shall be repeated while the sample is gradually dried, and when the fine aggregates in the form of a cone slump for the first time as the flow cone is pulled up, the condition of the sample at this moment shall be regarded as the saturated surface-dry condition.

Notes ([2]) The operation of 3.3 may be difficult in some cases due to the particle form or grading. In such cases, the fine aggregates remaining after the particles smaller than 0.15 mm (particles which pass the standard sieve of 150 μm specified in JIS Z 8801) are screend off may be used as the sample. In that case, the use of such a sample shall be supplementarily stated in the report.

([3]) The fine aggregates shall be packed in the flow cone flowing gradually and uniformly. In addition, an excess amount of the sample shall be packed in such a degree as to eliminate the necessity of adding the sample during or after the subsequent compacting operation.

([4]) The flow cone shall be lightly tapped with the tip of a tamping rod from positions about 10 mm apart from the surface of the flow cone. The time required for tapping 10 times shall preferably be about 5 sec.

3.4 About 300 g each of the sample in the saturated surface-dry condition shall be taken to serve as the sample for one test run of the specific gravity test and the water absorption test.

4. Test Method for Specific Gravity

4.1 The mass (m_{s1}) of the sample of 3.4 shall be measured.

4.2 Water shall be introduced into the pycnometer to overflowing and the mass (m_1) shall be measured with the cover on.

4.3 Empty the pycnometer and introduce water in a quantity sufficient to cover the sample (m_{s1}) of 4.1, then place the sample (m_{s1}) of 4.1, apply the cover, and expel the air existing between the particles by sufficiently shaking the sample and water. Additionally introduce water to fill the pycnometer ([5]) and then measure the mass (m_2).

Note ([5]) The temperature of the water which has filled the pycnometer shall not have a temperature variance of 5°C or more from that of the water in 4.2.

5. Test Method for Water Absorption Ratio

Measure the mass (m_{s2}) of the sample of 3.4, dry this sample at 100 to 110°C until a constant mass is obtained, cool in a desiccator to room temperature, and measure its mass (m_{s3}).

6. Calculation of Results

6.1 The bulk specific gravity values shall be calculated ([6]) from the following formulas and rounded off to 3 significant figures in accordance with JIS Z 8401.

$$D_{S1} = \frac{m_{S1}}{m_1 + m_{S1} - m_2}$$

$$D_{D1} = \frac{m_{S1}\dfrac{100}{(100+Q_1)}}{m_1 + m_{S1} - m_2}$$

where, D_{S1} : specific gravity in saturated surface-dry condition

D_{D1} : specific gravity in absolute dry condition

Q_1 : water absorption (mass percentage) (%)

m_{S1} : mass of sample in saturated surface-dry condition (g)

m_1 : total mass of pycnometer filled with water (g)

m_2 : total mass of pycnometer filled with sample and water (g)

Note ([6]) When the test is performed for only particles of fine aggregates 0.15 mm or larger in size (particles remaining on the 150 μm standard sieve), the specific gravity in absolute dry condition shall be calculated from the following formula and rounded off to 3 significant figures in accordance with JIS Z 8401.

$$D_{D2} = \frac{m_{D2}}{\dfrac{m_{D3}}{D_{D3}} + \dfrac{m_{D4}}{D_{D4}}}$$

where, D_{D2} : specific gravity in absolute dry condition

m_{D2} : total dry mass of fine aggregates (g)

m_{D3} : dry mass of particles of fine aggregates smaller than 0.15 mm (g)

D_{D3} : specific gravity in absolute dry condition of particles of fine aggregates smaller than 0.15 mm

m_{D4} : dry mass of particles of fine aggregates not smaller than 0.15 mm (g)

D_{D4} : specific gravity in absolute dry condition of particles of fine aggregates not smaller than 0.15 mm.

Determine the specific gravity in absolute dry condition of particles smaller than 0.15 mm by drying the sample at 100 to 100°C until a constant mass is obtained and performing a test by the testing method for the specific gravity of cement specified in 5 of JIS R 5201, as appropriate. In this operation, use water in place of mineral oil and about 80 g of sample.

The specific gravity in saturated surface-dry condition of fine aggregates in this case shall be calculated from the following formula by using the water absorption percentage calculated according to Note ([7]) to 6.2 and rounded off to 3 significant figures in accordance with JIS Z 8401.

$$D_{S2}=D_{D2}\times\left(\frac{100+Q_2}{100}\right)$$

where, D_{S2}: specific gravity in saturated surface-dry condition

D_{D2}: specific gravity in absolute dry condition

Q_2: water absorption (mass percentage) (%).

6.2 The water absorption percentage shall be calculated to the nearest 0.1 from the following formula ([7]):

$$Q_1=\frac{m_{S2}-m_{D1}}{m_{D1}}\times 100$$

where, Q_1: water absorption (mass percentage) (%)

m_{S2}: mass of sample in saturated surface-dry condition (g)

m_{D1}: mass of sample after drying (g)

Note ([7]) Where the test is performed for only particles of fine aggregates 0.15 mm or larger, the water absorption percentage shall be calculated to the nearest 0.1 by disregarding the water absorption ratio of particles smaller than 0.15 mm and by considering only the particles not smaller than 0.15 mm for the water absorption percentage of the fine aggregates.

$$Q_2=\frac{1}{100}Q_3\cdot P$$

where, Q_3: water absorption of particles 0.15 mm or larger (mass percentage) (%)

P: mass percentage of particles 0.15 mm or larger in fine aggregates.

6.3 The tests 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.

7. Accuracy

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.

8. Report

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

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

(2) Sampling position, date and time

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

(4) Bulk specific gravity

(5) Water absorption percentage

(6) In the case where the test has been conducted with aggregate particles smaller than 0.15 mm removed, the fact shall be noted in the report.