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(NSA)

**Slag aggregate for concrete —
Part 1 : Blast furnace slag aggregate**

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Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee as the result of proposal for revision of Japanese Industrial Standard submitted by Nippon Slag Association (NSA) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law applicable to the case of revision by the provision of Article 14.

Consequently **JIS A 5011-1:1997** is replaced with this Standard.

Attention is drawn to the possibility that some parts of this Standard may conflict with a patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have technical properties. The relevant Minister and the Japanese Industrial Standards Committee are not responsible for identifying the patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have the said technical properties.

JIS A 5011 consists of the following parts under the general title “*Slag aggregate for concrete*”.

Part 1 : Blast furnace slag aggregate

Part 2 : Ferronickel slag aggregate

Part 3 : Copper slag aggregate

Part 4 : Electric arc furnace oxidizing slag aggregate

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Slag aggregate for concrete — Part 1 : Blast furnace slag aggregate

Introduction This Japanese Industrial Standard specifies quality, etc. necessary to use the blast furnace slag, which is generated when smelting and extraction of pig iron from iron ore, as slag aggregate for concrete.

1 Scope This part of **JIS A 5011** specifies the blast furnace slag aggregate used for concrete.

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

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 aggregates*

JIS A 1104 *Methods of test for bulk density of aggregates and solid content in aggregates*

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 K 0050 *General rules for chemical analysis*

JIS K 0121 *General rules for atomic absorption spectrometry*

JIS K 8001 *General rule for test methods of reagents*

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

JIS Z 9015-0 *Sampling procedures for inspection by attributes—Part 0 : Introduction to the JIS Z 9015 attribute sampling system*

3 Type, classification and designation

3.1 Type The type of blast furnace slag aggregate shall be as given in table 1.

Table 1 Type

Type	Symbol	Remarks
Blast furnace slag coarse aggregate	BFG	Aggregate obtained by slowly cooling molten slag which is generated simultaneously with pig iron in a blast furnace and adjusting grain size
Blast furnace slag fine aggregate	BFS	Aggregate obtained by rapidly cooling molten slag which is generated simultaneously with pig iron with water, air, etc. in a blast furnace and adjusting grain size

3.2 Classification by grain size The classification by grain size of blast furnace slag aggregate shall be as follows.

- a) The classification by grain size of blast furnace slag coarse aggregate shall be as given in table 2.

Table 2 Classification by grain size of blast furnace slag coarse aggregate

Classification	Range of grain size mm	Symbol
Blast furnace slag coarse aggregate 4005	40 to 5	BFG40-5
Blast furnace slag coarse aggregate 4020	40 to 20	BFG40-20
Blast furnace slag coarse aggregate 2505	25 to 5	BFG25-5
Blast furnace slag coarse aggregate 2005	20 to 5	BFG20-5
Blast furnace slag coarse aggregate 2015	20 to 15	BFG20-15
Blast furnace slag coarse aggregate 1505	15 to 5	BFG15-5

- b) The classification by grain size of blast furnace slag fine aggregate shall be as given in table 3.

Table 3 Classification by grain size of blast furnace slag fine aggregate

Classification	Range of grain size mm	Symbol
5 mm blast furnace slag fine aggregate	5 max.	BFS5
2.5 mm blast furnace slag fine aggregate	2.5 max.	BFS2.5
1.2 mm blast furnace slag fine aggregate	1.2 max.	BFS1.2
5 mm to 0.3 mm blast furnace slag fine aggregate	5 to 0.3	BFS5-0.3

3.3 Classification by density in oven dry condition, water absorption and bulk density The classification by density in oven dry condition, water absorption and bulk density of blast furnace slag coarse aggregate shall be as given in table 4.

Table 4 Classification by density in oven dry condition, water absorption and bulk density of blast furnace slag coarse aggregate

Classification	Density in oven dry condition g/cm ³	Water absorption %	Bulk density kg/L
L	2.2 min.	6.0 max.	1.25 min.
N	2.4 min.	4.0 max.	1.35 min.

3.4 Designation The designation of blast furnace slag aggregate shall be as follows.

Example BFG 40-5 L

BFS 2.5

Indicates classification by density in oven dry condition, water absorption coefficient and bulk density of blast furnace slag coarse aggregate

Indicates classification by grain size of blast furnace slag aggregate

Indicates type of blast furnace slag aggregate

4 Quality

4.1 General matters The blast furnace slag aggregate shall not contain amount of materials which may harmfully influence to concrete quality.

4.2 Chemical composition and physical and chemical properties The blast furnace slag aggregate shall be tested in accordance with 5.2 to 5.6 and shall conform to table 5.

Table 5 Chemical composition and physical and chemical properties

Item		Blast furnace slag coarse aggregate		Blast furnace slag fine aggregate	Applicable test sub-clause
		L	N		
Chemical composition	Calcium oxide (as CaO) %	45.0 max.		45.0 max.	5.2 Annex 1
	Total sulfur (as S) %	2.0 max.		2.0 max.	
	Sulfur trioxide (as SO ₃) %	0.5 max.		0.5 max.	
	Total iron (as FeO) %	3.0 max.		3.0 max.	
Density in oven dry condition g/cm ³		2.2 min.	2.4 min.	2.5 min.	5.3
Water absorption %		6.0 max.	4.0 max.	3.5 max.	
Bulk density kg/L		1.25 min.	1.35 min.	1.45 min.	5.4
Immersion in water		Shall be no phenomena such as cracks, decomposition, mudiness, powdering.		—	5.5
Irradiation by ultraviolet light (360.0 nm)		Shall be no light emission or uniform purple luminance.		—	5.6

4.3 Grain size and fineness modulus

4.3.1 Blast furnace slag coarse aggregate The grain size and fineness modulus of blast furnace slag coarse aggregate shall be as follows.

- a) The grain size of blast furnace slag coarse aggregate shall be tested in accordance with 5.7 and shall conform to table 6.

Table 6 Grain size of blast furnace slag coarse aggregate

Classification	Nominal sieve size ⁽¹⁾						
	Mass percentage of aggregate passing sieve %						
	50	40	25	20	15	10	5
Blast furnace slag coarse aggregate 4005	100	95 to 100	—	35 to 70	—	10 to 30	0 to 5
Blast furnace slag coarse aggregate 4020	100	90 to 100	20 to 55	0 to 15	—	0 to 5	—
Blast furnace slag coarse aggregate 2505	—	100	95 to 100	—	30 to 70	—	0 to 10
Blast furnace slag coarse aggregate 2005	—	—	100	90 to 100	—	20 to 55	0 to 10
Blast furnace slag coarse aggregate 2015	—	—	100	90 to 100	—	0 to 10	0 to 5
Blast furnace slag coarse aggregate 1505	—	—	—	100	90 to 100	40 to 70	0 to 15

Note ⁽¹⁾ The nominal sieve sizes are the nominal sieve opening sizes of 53 mm, 37.5 mm, 26.5 mm, 19 mm, 16 mm, 9.5 mm and 4.75 mm as specified in JIS Z 8801-1, respectively.

- b) The fineness modulus of blast furnace slag coarse aggregate shall not differ from the value specified at the time of purchase agreement by ± 0.30 or more.

4.3.2 Blast furnace slag fine aggregate The grain size and fineness modulus of blast furnace slag fine aggregate shall be as follows.

- a) The grain size of blast furnace slag fine aggregate shall be tested in accordance with 5.7 and shall conform to table 7.

Table 7 Grain size of blast furnace slag fine aggregate

Classification	Nominal sieve size ⁽²⁾						
	Mass percentage of aggregate passing sieve %						
	10	5	2.5	1.2	0.6	0.3	0.15
5 mm blast furnace slag fine aggregate	100	90 to 100	80 to 100	50 to 90	25 to 65	10 to 35	2 to 15
2.5 mm blast furnace slag fine aggregate	100	95 to 100	85 to 100	60 to 95	30 to 70	10 to 45	2 to 20
1.2 mm blast furnace slag fine aggregate	—	100	95 to 100	80 to 100	35 to 80	15 to 50	2 to 20
5 mm to 0.3 mm blast furnace slag fine aggregate	100	95 to 100	65 to 100	10 to 70	0 to 40	0 to 15	0 to 10

Note ⁽²⁾ The nominal sieve sizes are the nominal sieve opening sizes of 9.5 mm, 4.75 mm, 2.36 mm, 1.18 mm, 600 μ m, 300 μ m and 150 μ m as specified in JIS Z 8801-1, respectively.

- b) The fineness modulus of blast furnace slag fine aggregate shall not differ from the value specified at the time of purchase agreement by ± 0.20 or more.

4.4 Storage stability at the time of high atmospheric temperature of blast furnace slag fine aggregate The storage stability at the time of high atmospheric temperature of blast furnace slag fine aggregate shall be confirmed by the agreement between the purchaser and the supplier.

Information : When confirming the storage stability, the test shall be performed in accordance with Annex 2, and when the result of judgment is A, the storage shall be taken to be stable.

5 Testing method

5.1 Sampling The sample representing the material shall be taken and reduced by the reasonable procedure.

5.2 Chemical analysis test The chemical analysis test of blast furnace slag aggregate shall be in accordance with Annex 1.

5.3 Test for density in oven dry condition and water absorption The test for density in oven dry condition and water absorption of blast furnace slag aggregate shall be as follows.

- a) **Blast furnace slag coarse aggregate** The test of density in oven dry condition and water absorption of blast furnace slag coarse aggregate shall be in accordance with JIS A 1110.

The sample in 4 c) of JIS A 1110 shall be obtained by sufficiently washing the sample in 4 a) of JIS A 1110 with water, removing the foreign particles and others attached to the surface of grain, drying at a temperature of $105\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ until it reaches constant mass and cooling to ordinary temperature.

- b) **Blast furnace slag fine aggregate** The tests of density in oven dry condition and water absorption of blast furnace slag fine aggregate shall be in accordance with JIS A 1109 ⁽³⁾⁽⁴⁾.

Notes ⁽³⁾ In the case of blast furnace slag fine aggregate containing a large amount of fine materials, the sample washed in accordance with the method specified in JIS A 1103 may be used. In this case, that effect shall be written together in the report.

⁽⁴⁾ The method for preparing the saturated and surface-dry condition of 5 mm to 0.3 mm blast furnace slag fine aggregate containing a small amount of fine materials shall be as specified in 5 d) of JIS A 1110 after taking out the sample in 4 b) of JIS A 1109 from the water and dewatering. In this case, that effect shall be written together in the report.

5.4 Bulk density test The bulk density test of blast furnace slag aggregate shall be in accordance with JIS A 1104.

5.5 Immersion test in water The immersion test in water of blast furnace slag coarse aggregate shall be as follows.

- a) **Sample** Take about 2 000 g of blast furnace slag coarse aggregate, sieve with a 10 mm sieve and put the aggregate remained in the sieve into a container. Pour water to this, stir vigorously in the water and remove fine grains attached to the surface or contained in the cavity of furnace slag coarse aggregate. Make the washing water in which fine grains are suspended flow by inclining the container. Put the blast furnace slag coarse aggregate contained in the container on a 10 mm sieve which is placed in another container. Again add water in the blast furnace slag coarse aggregate in the container, stir and repeat this operation until washing water becomes clear. Take the blast furnace slag coarse aggregate of 10 mm or more which does not contain the fine grains obtained in this way as the sample.
- b) **Method** Take 30 grains of samples randomly, immerse them under water at a temperature of $20\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ for two days, and observe.
- c) **Result and judgment** As a result of observation, when all grains of the sample are free from any phenomena such as cracks, decomposition, muddiness and powdering, the sample shall be acceptable. When there are any phenomena such as cracks, decomposition, muddiness, powdering even in one grain, the retest shall be performed.

5.6 Irradiation test by ultraviolet light (360.0 nm) The irradiation test by ultraviolet light of blast furnace slag coarse aggregate shall be as follows.

- a) **Sample** Take about 2 000 g of blast furnace slag coarse aggregate of an air-dried condition, sieve with a 10 mm sieve, take out 10 grains randomly from the aggregate remained in the sieve and take them as the sample.
- b) **Device** Use the UV identification device which is capable of irradiating ultraviolet light of a wavelength of 360.0 nm without containing visible light by combining a quartz lamp for analysis and a nickel oxide glass (for UV filter).
- c) **Method** Break each of 10 grains of sample with a chisel and a hammer to obtain a fresh fractured section. Next, observe this fractured section by irradiating ultraviolet light of wavelength 360.0 nm to it.
- d) **Result and judgment** As a result of observation, when there is no light emission or when there is uniform purple luminance, judge it to be acceptable. When even one grain shows abnormal light emission, perform the retest.

5.7 Grain size test The grain size test of blast furnace slag aggregate shall be in accordance with JIS A 1102.

6 Inspection method The lot size shall be determined in accordance with JIS Z 9015-0 or the agreement between the purchaser and the supplier, the sample shall be taken in accordance with the reasonable sampling inspection method, tested in accordance with clause 5 and the test result shall conform to clause 4.