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**Slag aggregate for concrete — Part 4:
Electric arc furnace oxidizing slag
aggregate**

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Foreword

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JIS A 5011 consists of the following 4 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 4: Electric arc furnace oxidizing slag aggregate

Introduction This Standard specifies quality, etc. necessary to use the electric arc furnace oxidizing slag, which is sub-produced when iron scrap is melted and refined to produce steel, as aggregates for concrete. This Standard has newly established because the effective use of the electric arc furnace oxidizing slag as aggregates for concrete has been ascertained.

1 Scope This Standard provides for the electric arc furnace oxidizing slag aggregate used for concrete ⁽¹⁾.

Note ⁽¹⁾ In every manufacturing process of electric arc furnace oxidizing slag aggregates, this application is limited to one manufactured at the factory where measures, with which reducing slag does not mix, are considered.

2 Normative references The following standards contain provisions which, through reference in this Standard, 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 μ m 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 A 1145 *Method of test for alkali-silica reactivity of aggregates by chemical method*
- JIS A 1146 *Method of test for alkali-silica reactivity of aggregates by mortar-bar method*
- JIS K 0050 *General rules for chemical analysis*
- JIS K 0119 *General rules for X-ray fluorescence spectrometric analysis*
- 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 Types, classification and designation

3.1 Types Types of electric arc furnace oxidizing slag aggregates are as shown in table 1.

Table 1 Types

Type	Symbol	Particulars
Electric arc furnace oxidizing slag coarse aggregate	EFG	Slowly cooled electric arc furnace slag aggregates, which is generated simultaneously with molten steel in an electric arc furnace, and adjusting the particle size after removing the iron containing lumps ⁽²⁾ .
Electric arc furnace oxidizing slag fine aggregate	EFS	Slowly cooled or rapidly cooledg by water or air electric arc furnace slag aggregates, which is generated simultaneously with molten steel in an electric arc furnace, and adjusting the particle size after removing the iron containing lumps ⁽²⁾ .

Note ⁽²⁾ After the final crushing process slag containing metallic particles shall be removed on the belt conveyer for transportation by the magnetic separator with magnetic field strength of more than 600 gauss.

3.2 Classification by the particle size The classification by particle size of electric arc furnace oxidizing slag aggregates is as follows.

- a) The classification by particle size of electric arc furnace oxidizing slag coarse aggregate is as shown in table 2.

Table 2 The classification by particle size of coarse aggregate

Classification	Range of size of particle mm	Symbol
Electric arc furnace oxidizing slag coarse aggregate 4020	40 to 20	EFG40-20
Electric arc furnace oxidizing slag coarse aggregate 2005	20 to 5	EFG20-05
Electric arc furnace oxidizing slag coarse aggregate 2015	20 to 15	EFG20-15
Electric arc furnace oxidizing slag coarse aggregate 1505	15 to 5	EFG15-05

- b) The classification by particle size of electric arc furnace oxidizing slag fine aggregate is as shown in table 3.

Table 3 The classification by particle size of fine aggregate

Classification	Range of size of particle mm	Symbol
5 mm Electric arc furnace oxidizing slag fine aggregate	5 or less	EFS5
2.5 mm Electric arc furnace oxidizing slag fine aggregate	2.5 or less	EFS2.5
1.2 mm Electric arc furnace oxidizing slag fine aggregate	1.2 or less	EFS1.2
5-0.3 mm Electric arc furnace oxidizing slag fine aggregate	5 to 0.3	EFS5-0.3

3.3 Classification by the density in oven dry condition The classification by density in oven dry condition of electric arc furnace oxidizing slag aggregates is as shown in table 4.

Table 4 The classification by density in oven dry condition

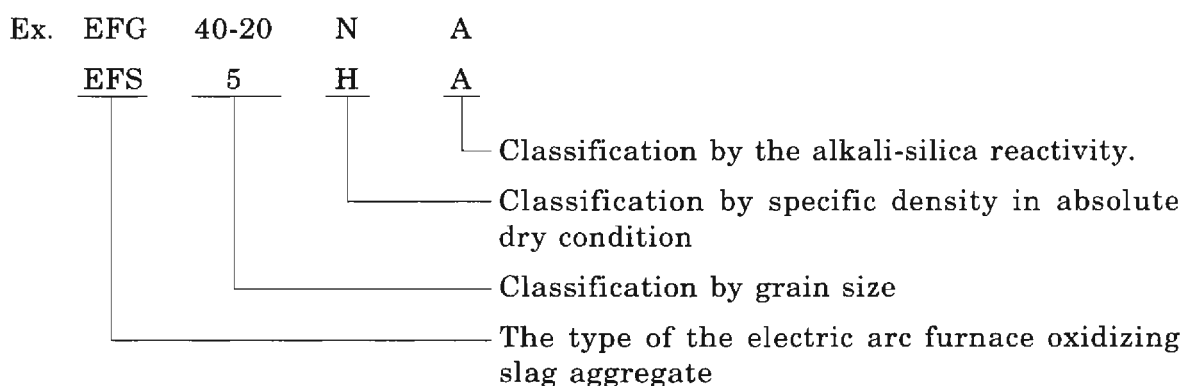
Classification	Density in oven dry condition g/cm ³
N	3.1 or over to and incl. 4.0
H	4.0 or over to and incl. 4.5

3.4 Classification by the alkali-silica reactivity Classification by the alkali-silica reactivity of electric arc furnace oxidizing slag aggregate is as shown in table 5.

Table 5 Classification by the alkali-silica reactivity

Classification	Particulars
A	The one judged as “harmless” by alkali-silica reactivity testing result
B	The one judged as “harmless” by alkali-silica reactivity testing result or is not examined.

3.5 Designation Designation of the electric arc furnace oxidizing slag aggregates is as follows.



4 Quality

4.1 General matter The electric arc furnace oxidizing slag aggregates shall not contain amount of materials which may harmfully influence to concrete quality.

4.2 Chemical composition and physical properties Electric arc furnace oxidizing slag aggregates shall be tested by 5.2 to 5.4, and conform to table 6.

Table 6 Chemical composition and physical properties

Item		Electric arc furnace oxidizing slag Coarse aggregate		Electric arc furnace oxidizing slag Fine aggregate		Applied test subclause
		N	H	N	H	
Chemical composition	Calcium oxide (As CaO) %	40.0 or less				5.2
	Magnesium oxide (As MgO) %	10.0 or less				
	Total iron (As FeO) %	50.0 or less				
	Basicity (As CaO/SiO ₂)	2.0 or less				
Density in oven dry condition g/cm ³		3.1 or over to and excl. 4.0	4.0 or over to and excl. 4.5	3.1 or over to and excl. 4.0	4.0 or over to and excl. 4.5	5.3
Water absorption %		2.0 or less				5.3
Bulk density kg/l		1.6 or more	2.0 or more	1.8 or more	2.2 or more	5.4

4.3 Alkali-silica reactivity Regarding to the alkali-silica reactivity, electric arc furnace oxidizing slag aggregates shall be examined by 5.5, and be judged as “Harmless” or “Not harmless”.

Information : When the aggregate is judged as “Not harmless”, the measures listed by annex 2 (informative) shall be taken for control .

4.4 Grain size and fineness modulus

4.4.1 Electric arc furnace oxidizing slag coarse aggregate Grain size and fineness modulus of electric arc furnace slag coarse aggregate are defined as follows.

- a) Grain size of electric arc furnace oxidizing slag coarse aggregate shall be tested by 5.6 and shall comply with table 7.

Table 7 Grain size distribution limits of electric arc furnace oxidizing slag coarse aggregates

Classification	Nominal size of sieve ⁽³⁾						
	Mass percentage of fraction passing sieve %						
	50	40	25	20	15	10	5
Electric arc furnace oxidizing slag coarse aggregate 4020	100	90 to 100	20 to 55	0 to 15	—	0 to 5	—
Electric arc furnace oxidizing slag coarse aggregate 2005	—	—	100	90 to 100	—	20 to 55	0 to 10
Electric arc furnace oxidizing slag coarse aggregate 2015	—	—	100	90 to 100	—	0 to 10	0 to 5
Electric arc furnace oxidizing slag coarse aggregate 1505	—	—	—	100	90 to 100	40 to 70	0 to 15

Note ⁽³⁾ The nominal-sizes of sieve are specified opening of sieves 53 mm, 37.5 mm, 26.5 mm, 19 mm, 16 mm, 9.5 mm, and 4.75 mm as defined in JIS Z 8801-1.

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

4.4.2 Electric arc furnace oxidizing slag fine aggregate Grain size and fineness modulus of electric arc furnace oxidizing slag fine aggregate are defined as follows.

- a) Grain size of electric arc furnace oxidizing slag fine aggregate shall be tested by **5.6** and shall comply with table 8.

Table 8 Grain size distribution limits of electric arc furnace oxidizing slag fine aggregates

Classification	Nominal size of sieve ⁽⁴⁾						
	Mass percentage of fraction passing sieve %						
	10	5	2.5	1.2	0.6	0.3	0.15
5 mm Electric arc furnace oxidizing 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 Electric arc furnace oxidizing slag fine aggregate	100	95 to 100	85 to 100	60 to 95	30 to 70	10 to 45	5 to 20
1.2 mm Electric arc furnace oxidizing slag fine aggregate	—	100	95 to 100	80 to 100	35 to 80	15 to 50	10 to 30
5 to 0.3 mm Electric arc furnace oxidizing slag fine aggregate	100	95 to 100	45 to 100	10 to 70	0 to 40	0 to 15	0 to 10

Note ⁽⁴⁾ The nominal-size of sieves are specified opening of sieves 9.5 mm, 4.75 mm, 2.36 mm, 1.18 mm, 600 μm , 300 μm , and 150 μm as defined in **JIS Z 8801-1**.

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

5 Testing method

5.1 Sampling The sample representing the material shall be obtained and reduced to nearly the required amount by a reasonable procedure.

5.2 Chemical analysis test Chemical analysis test shall be done by annex 1 (normative).

5.3 Tests for density in oven dry condition and water absorption Tests for density in oven dry condition and water absorption are by following.

5.3.1 Electric arc furnace oxidizing slag coarse aggregate Tests for density in oven dry condition and water absorption of electric arc furnace oxidizing slag coarse aggregate shall comply with **JIS A 1110**. However, minimum mass of the sample used for a test shall be decided roughly according to the following expression.

$$m_{\min} = d_{\max} \times D_e / 25$$

where, $m_{\min}$: Minimum mass of sample (kg)

$d_{\max}$: Maximum size of coarse aggregate (mm)

D_e : Presumed density of coarse aggregate (g/cm³)

5.3.2 Electric arc furnace oxidizing slag fine aggregate Tests for density in oven dry condition and water absorption of electric arc furnace oxidizing slag fine aggregate shall comply with **JIS A 1109**⁽⁵⁾⁽⁶⁾. However, mass of the sample used for the test shall be about 3 kg.

Notes ⁽⁵⁾ For the electric arc furnace oxidizing slag fine aggregates, which contain massive finer particles, it is allowed to wash the sample before test according to the method of **JIS A 1103**. In this case, it shall be added to the report.

⁽⁶⁾ The procedure to make saturated surface-dry condition of 5 mm to 0.3 mm electric arc furnace oxidizing slag fine aggregate, which contains small amount of finer particles, is by taking out the sample shown by **4 b)** of **JIS A 1109** from water and draining, and shall comply with **5 d)** of **JIS A 1110**. In this case, it shall be added to the report.

5.4 Bulk density test Bulk density test shall comply with **JIS A 1104**.

5.5 Alkali-silica reactivity test Alkali-silica reactivity test shall comply with **JIS A 1145**, when, as the result, it is not judged as “harmless”, it shall be judged by additional test by **JIS A 1146**. However, the particle size distribution of the sample from 1.2 mm electric arc furnace oxidizing slag fine aggregate is as table 9.

Table 9 The particle size distribution of the sample used for mortar bar test for 1.2 mm electric arc furnace oxidizing slag fine aggregate

Particle size mm	Mass percentage of fraction %
2.5 to 1.2	5
1.2 to 0.6	35
0.6 to 0.3	40
0.3 to 0.15	20

Mixture proportion of mortar for the mortar bar method is cement 1, water 0.5, and electric arc furnace oxidizing slag fine aggregate 3.2 by mass. The amount of each material for one test batch is as follows.

Water + NaOH solution	300 ml ± 1 ml
Cement	600 g ± 1 g
Electric arc furnace oxidizing slag fine aggregate (Saturated surface-dry condition)	1 920 g ± 1 g

5.6 Determination of the particle size The test for particle size shall comply with **JIS A 1102**.