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**Slag aggregate for concrete—
Part 5: Coal gasification slag
aggregate**

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Foreword

This Japanese Industrial Standard has been established by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee according to the proposal for establishment of Japanese Industrial Standard submitted by Japan Coal Energy Center (JCOAL)/Japanese Standards Association (JSA) with a draft being attached, based on the provision of Article 12, paragraph (1) of the Industrial Standardization Act.

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Slag aggregate for concrete—

Part 5: Coal gasification slag aggregate

1 Scope

This Japanese Industrial Standard provides requirements for coal gasification slag aggregate to be 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 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 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 1158 *Method for reducing samples of aggregate to testing size*

JIS K 0050 *General rules for chemical analysis*

JIS K 0058-1 *Test methods for chemicals in slags—Part 1: Leaching test method*

JIS K 0058-2 *Test methods for chemicals in slags—Part 2: Test method for acid extractable contents of chemicals*

JIS K 0116 *General rules for atomic emission spectrometry*

JIS K 0119 *General rules for X-ray fluorescence analysis*

JIS K 0211 *Technical terms for analytical chemistry (General part)*

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

JIS K 8085 *Ammonia solution (Reagent)*

JIS K 8102 *Ethanol (95) (Reagent)*

JIS K 8155 *Barium chloride dihydrate (Reagent)*

JIS K 8180 *Hydrochloric acid (Reagent)*

JIS K 8223 *Perchloric acid (Reagent)*

JIS K 8432 *Magnesium oxide (Reagent)*

JIS K 8541 *Nitric acid (Reagent)*

- JIS K 8617 *Calcium carbonate (Reagent)*
JIS K 8896 *Methyl red (Reagent)*
JIS M 8810 *Coal and coke—General rules for sampling, analysis and testing*
JIS M 8819 *Coal and coke—Mechanical methods for ultimate analysis*
JIS P 3801 *Filter paper (for chemical analysis)*
JIS Q 17025 *General requirements for the competence of testing and calibration laboratories*
JIS Q 17050-1 *Conformity assessment—Supplier's declaration of conformity—Part 1: General requirements*
JIS Q 17050-2 *Conformity assessment—Supplier's declaration of conformity—Part 2: Supporting documentation*
JIS Z 2616 *General rules for determination of sulfur in metallic materials*
JIS Z 8401 *Rounding of numbers*
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 following terms and definitions, and those given in **JIS A 0203** and **JIS K 0211** apply.

3.1

coal gasification slag fine aggregate mix ratio

absolute volume ratio of coal gasification slag fine aggregate to the entire fine aggregate, expressed in percentage

Note to entry 1 This term is hereafter referred to as CGS mix ratio.

3.2

environmentally sound quality

quality which a coal gasification slag fine aggregate should have so that every environmental media such as soil, ground water, and sea water, which are to be exposed to the influence of the coal gasification slag fine aggregate somewhere in its rationally expected lifecycle, can meet their own environmental standards

The rationally expected lifecycle of a coal gasification slag fine aggregate extends from shipment, construction of concrete structure, production and use of concrete product, all through to the reuse after dismantling and final disposal.

3.3

environmental safety type inspection

inspection performed to determine whether a coal gasification slag fine aggregate, having been adjusted to a suitable grain size and mixed with other materials (including other slag aggregate) to be ready for use in concrete and then verified for all other product quality requirements than environmentally sound quality, satisfies a specified set of requirements set in place for verifying environmentally sound quality of a product

3.4

environmental safety acceptance inspection

inspection performed for assurance of, at the time of delivery, the environmentally sound quality of a coal gasification slag fine aggregate manufactured under the same conditions as the one that passed the environmental safety type inspection

3.5

use simulation sample

sample prepared simulating the condition of a coal gasification slag fine aggregate in the most critical exposure environment in terms of environmental safety that can be rationally expected to occur in its lifecycle that extends from shipment, use, all through to the reuse after dismantling and final disposal

3.6

aggregate sample

sample extracted by an adequate method from the bulk of a coal gasification slag fine aggregate to be supplied for an environmental safety type inspection or environmental safety acceptance inspection

3.7

environmentally sound quality criteria

criteria values such as elution level and acid extractable content of chemical components that are required to be tested for assuring the environmentally sound quality

Note to entry 1 For the port application as defined in **3.12**, the environmentally sound quality criteria values consist only of elution level limits.

3.8

criteria values for environmental safety acceptance inspection

criteria values which a coal gasification slag fine aggregate sample should satisfy in the environmental safety acceptance inspection in order to validate its conformance to the environmentally sound quality criteria

3.9

environmental safety type tests

tests, specifically a leaching test and an acid extractable content test, performed for the environmental safety type inspection of the coal gasification slag fine aggregate to verify its conformity to the environmentally sound quality criteria

Note to entry 1 For the port application as defined in **3.12**, only the leaching test shall be carried out.

3.10

environmental safety acceptance tests

tests, specifically a leaching test and an acid extractable content test, performed for the environmental safety acceptance inspection of the coal gasification slag fine aggregate to verify its conformity to the criteria values for environmental safety acceptance inspection

Note to entry 1 For the port application as defined in **3.12**, only the leaching test shall be carried out.

3.11

general application

application of the concrete structure or concrete product, for which a coal gasification slag fine aggregate is intended, for general civil engineering and construction excluding the port application defined in **3.12**

Note to entry 1 Concrete structure or concrete product is hereafter referred to as the concrete structure etc.

3.12

port application

application of concrete structures etc., for which a coal gasification slag fine aggregate is intended, for port facilities and other related facilities where the concrete structures etc. are directly exposed to seawater, and are installed for semi-permanent use with no plan for dismantling or reuse

Note to entry 1 Structures for this application include quays, breakwaters, revetment, banks, and piers.

4 Classification and divisions

4.1 Classification

Classification of coal gasification slag aggregate is shown in Table 1.

Table 1 Classification of coal gasification slag aggregate

Classification	Symbol	Description
Coal gasification slag fine aggregate	CGS	Aggregate obtained by water-granulating the molten slag generated in the gasification of coal in a gasification furnace, and then adjusting its grain size by abrasion or other suitable method.

4.2 Division according to grain size

Division according to grain size is shown in Table 2.

Table 2 Division according to grain size

Division	Grain size range mm	Symbol
5 mm coal gasification slag fine aggregate	5 max.	CGS5
2.5 mm coal gasification slag fine aggregate	2.5 max.	CGS2.5
1.2 mm coal gasification slag fine aggregate	1.2 max.	CGS1.2
5 mm to 0.3 mm coal gasification slag fine aggregate	5 to 0.3	CGS5-0.3

4.3 Division according to alkali-silica reactivity

Division according to alkali-silica reactivity is shown in Table 3.

Table 3 Division according to alkali-silica reactivity

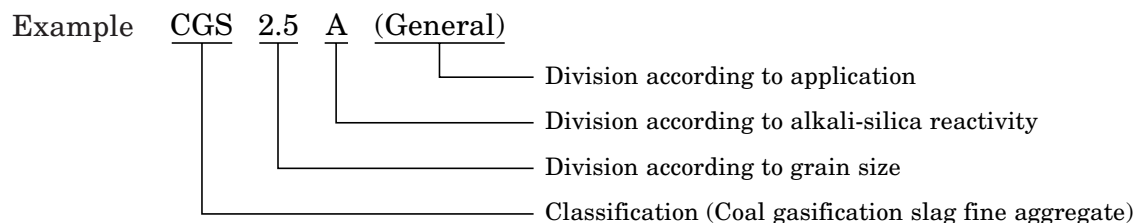
Division	Description
A	Those judged as "harmless" in alkali-silica reactivity test
B	Those judged as "not harmless" in alkali-silica reactivity test, or those not subjected to the test

4.4 Division according to application

The coal gasification slag aggregates are divided into those intended for general application and port application.

5 Designation

Designation of coal gasification slag aggregate shall be as follows:



6 Quality

6.1 General

The coal gasification slag fine aggregate shall not contain harmful amount of any material that may have an adverse effect on the quality of concrete.

In this document, values indicated in percent are mass fractions %.

6.2 Chemical composition and physical properties

When tested in accordance with 7.2, the chemical composition and physical properties shall conform to the requirements in Table 4.

The density in oven-dry condition shall not vary by more than $\pm 0.1 \text{ g/cm}^3$ from the sample value in the period agreed between the purchaser and the manufacturer.

The sample value of density in oven-dry condition shall be specified by the manufacturer based on estimation from the ash composition of the coal or the past actual values.

Table 4 Chemical composition and physical properties

Item		Coal gasification slag fine aggregate	Applicable test subclause
Chemical composition	Calcium oxide (as CaO) %	40.0 max.	7.2.1
	Magnesium oxide (as MgO) %	20.0 max.	
	Sulfur trioxide (as SO ₃) %	0.5 max.	
	Total iron (as FeO) %	25.0 max.	
Carbon content %		0.10 max.	7.2.1
Density in oven-dry condition g/cm ³		2.5 min.	7.2.2
Water absorption %		1.5 max.	7.2.2
Bulk density kg/L		1.50 min.	7.2.3

6.3 Grain size, fineness modulus and content of materials finer than 75 µm sieve

6.3.1 Grain size

The grain size shall be tested according to **7.3.1**, and shall be within the applicable range as given in Table 5.

Table 5 Grain size

Unit: %

Division	Mass fraction of aggregate passing sieve						
	Nominal sieve size ^{a)}						
	10 mm	5 mm	2.5 mm	1.2 mm	0.6 mm	0.3 mm	0.15 mm
5 mm coal gasification 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 coal gasification 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 coal gasification 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 coal gasification slag fine aggregate	100	95 to 100	65 to 100	30 to 90	10 to 50	0 to 15	0 to 10
Note ^{a)} The above sieve sizes correspond to nominal sieve apertures 9.5 mm, 4.75 mm, 2.36 mm, 1.18 mm, 0.6 mm, 0.3 mm and 0.15 mm, that are specified in JIS Z 8801-1 .							

6.3.2 Fineness modulus

The fineness modulus shall be within ± 0.20 of the value agreed between the purchaser and the manufacturer.

6.3.3 Content of materials finer than 75 µm sieve

The content of materials finer than 75 µm sieve shall be tested according to **7.3.2**, and shall satisfy the following.

- a) A required value shall be agreed between the purchaser and the manufacturer so that the content of materials finer than 75 µm sieve never exceeds 9.0 % including the permitted deviation specified in b).
- b) The permitted deviation from the agreed value in a) is ± 2.0 %.

6.4 Alkali-silica reactivity

The alkali-silica reactivity shall be tested according to 7.4, and shall be judged as “harmless” or “not harmless”; aggregates judged as “harmless” shall be applied.

6.5 Environmentally sound quality criteria

Either of the following criteria shall apply depending on the application of the concrete structure etc. for which the coal gasification slag fine aggregate is intended.

Where the application of the concrete structure etc. is yet to be specified, criteria for general application shall apply.

- a) **General application** Where the concrete structure etc., for which the coal gasification slag fine aggregate is intended, is for a general application, the aggregate shall be tested by the method specified in 7.5 and shall conform to the criteria given in Table 6.

Table 6 Environmentally sound quality criteria for general application

Item	Elution level mg/L	Acid extractable content ^{a)} mg/kg
Cadmium (Cd)	0.01 max.	150 max.
Lead (Pb)	0.01 max.	150 max.
Hexavalent chromium [Cr(VI)]	0.05 max.	250 max.
Arsenic (As)	0.01 max.	150 max.
Mercury (Hg)	0.000 5 max.	15 max.
Selenium (Se)	0.01 max.	150 max.
Fluorine (F)	0.8 max.	4 000 max.
Boron (B)	1 max.	4 000 max.
Note ^{a)} “Acid extractable content” is a content of a specific element that can be extracted from aggregate with acids, and not a total mass of that element contained in the aggregate.		

- b) **Port application** Where the concrete structure etc., for which the coal gasification slag fine aggregate is intended, is for a port application, the aggregate shall be tested by the method specified in 7.5 and shall conform to the criteria given in Table 7.

Table 7 Environmentally sound quality criteria for port applications

Unit: mg/L

Item	Elution level
Cadmium (Cd)	0.03 max.
Lead (Pb)	0.03 max.
Hexavalent chromium [Cr(VI)]	0.15 max.
Arsenic (As)	0.03 max.
Mercury (Hg)	0.001 5 max.
Selenium (Se)	0.03 max.
Fluorine (F)	15 max.
Boron (B)	20 max.

7 Test methods

7.1 Sampling and reduction of sample

Sample shall be taken so as to represent the lot to be tested and reduced according to the method described in **JIS A 1158**.

7.2 Chemical analysis and physical properties test

7.2.1 Analysis of chemical composition and carbon content

The analysis of chemical composition and carbon content shall be in accordance with Annex A.

7.2.2 Tests for density in oven-dry condition and water absorption

The tests for density in oven-dry condition and water absorption shall be in accordance with **JIS A 1109**.

For coal gasification slag fine aggregate with a grain size 5 mm to 0.3 mm and with a small content of materials finer than 75 μm sieve, the sample shall be first subjected to the water absorption procedure specified in 4 b) of **JIS A 1109**, and then brought to the saturated and surface-dry condition by the procedure specified in 4 e) of **JIS A 1110**. For coal gasification slag fine aggregate with a larger content of material finer than 75 μm sieve, the sample washed by the procedure specified in **JIS A 1103** may be supplied for the test. If either of these has been the case, it shall be so stated in the test report.

7.2.3 Bulk density test

The bulk density test shall be in accordance with **JIS A 1104**.

7.3 Grain size test and test of content of materials finer than 75 μm sieve

7.3.1 Grain size test

The grain size test shall be in accordance with **JIS A 1102**.