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Silica fume for use in concrete

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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 Japan Silica Fume Technology Associates (JST)/Japanese Standards Association (JSA) 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 6207:2011** is replaced with this Standard.

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Silica fume for use in concrete

Introduction

Silica fume is ultrafine particles collected from exhaust gas generated during production of metallic silicon or ferrosilicon in electric arc furnaces. The use of silica fume for an admixture for concrete has long been obscure in Japan because the silica fume production is limited due to high cost of electricity. However, as the remarkable effect of silica fume in enhancing the strength, durability and workability of concrete has been widely recognized, the use of imported silica fume has become increasingly common. This Standard was first established in 2000 for responding to the demand for a quality standard for silica fume. Since the last revision which was made in 2011, the applications of silica fume have diversified and the relevant technology advanced. This revision's aim is to revise some of the quality requirements and test procedures in order to accommodate and reflect these changes.

No corresponding International Standard has been established at this point. The comparison table between previous and current editions of this Standard on technically significant revisions is given in Annex G.

1 Scope

This Standard specifies the silica fume to be used as an admixture for concrete or mortar (hereafter referred to as silica fume).

NOTE : Silica fume is available in powdery, granular and slurry forms.

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 1108 *Method of test for compressive strength of concrete*

JIS A 1116 *Method of test for unit mass and air content of fresh concrete by mass method*

JIS A 1128 *Method of test for air content of fresh concrete by pressure method*

JIS A 1132 *Method of making and curing concrete specimens*

JIS A 1171 *Test methods for polymer-modified mortar*

JIS A 5308 *Ready-mixed concrete*

JIS A 6204 *Chemical admixtures for concrete*

JIS H 6201 *Platinum crucibles for chemical analysis*

JIS K 0050 *General rules for chemical analysis*

- JIS K 0119 *General rules for X-ray fluorescence analysis*
- JIS K 8101 *Ethanol (99.5) (Reagent)*
- JIS K 8105 *Ethylene glycol (Reagent)*
- JIS K 8359 *Ammonium acetate (Reagent)*
- JIS K 8617 *Calcium carbonate (Reagent)*
- JIS K 8799 *Phenolphthalein (Reagent)*
- JIS M 8853 *Methods for chemical analysis of aluminosilicate raw materials for ceramics*
- JIS Q 0030 *Terms and definitions used in connection with reference materials*
- JIS R 1301 *Porcelain crucibles for chemical analysis*
- JIS R 1616 *Methods for chemical analysis of fine silicon carbide powders for fine ceramics*
- JIS R 1626 *Measuring methods for the specific surface area of fine ceramic powders by gas adsorption using the BET method*
- JIS R 3503 *Glass apparatus for chemical analysis*
- JIS R 3505 *Volumetric glassware*
- JIS R 5201 *Physical testing methods for cement*
- JIS R 5202 *Methods for chemical analysis of cements*
- JIS R 5204 *Chemical analysis method of cement by x-ray fluorescence*
- JIS R 5210 *Portland cement*
- JIS Z 1505 *Kraft paper sacks — For cement*
- JIS Z 1651 *Flexible intermediate bulk containers (FIBCs) for non-dangerous goods*

3 Terms and definitions

For the purposes of this Standard, the following terms and definitions apply.

3.1 silica fume

spherical ultrafine particles mainly composed of amorphous silicon dioxide, collected from exhaust gas produced in manufacturing metallic silicon or ferrosilicon by electric arc furnaces

3.2 powdery silica fume

silica fume in the state as collected, and yet to be densified or suspended in water

3.3 granular silica fume

silica fume obtained by enlarging the apparent particle diameter of powdery silica fume with densification treatment, in order to facilitate its transportation or handling

3.4 silica fume slurry

silica fume suspended in water in order to facilitate transportation or handling

3.5 solid content

the mass of solids obtained after drying silica fume slurry at 105 °C to 110 °C to constant mass, divided by the mass before drying, expressed in percentage

3.6 standard mortar

mortar used as a reference in quality test of silica fume, prepared by using the ordinary portland cement specified in **JIS R 5210** as a binder

3.7 test mortar

mortar used for quality test of silica fume, prepared by mixing the ordinary portland cement used in the standard mortar as a binder and the silica fume under test by the ratio of 9 to 1 in mass

3.8 activity index

the value, in percentage, of the ratio of the compressive strength of the test mortar to the compressive strength of the standard mortar

3.9 flow

a diameter of mortar, measured in mm, which has spread naturally without application of vibration or impact when the flow cone is lifted in the flow test specified in clause 12 of **JIS R 5201**

4 Classification

Silica fume shall be classified into the following three classes according to the form of the product.

- a) Powdery silica fume
- b) Granular silica fume
- c) Silica fume slurry

5 Quality

5.1 Powdery silica fume and granular silica fume

The quality of powdery silica fume and granular silica fume, when the sample in clause 6 is tested according to clause 7, shall conform to the specification in Table 1.

For density, the result of measurement conducted by the manufacturer or the supplier shall be recorded in the test report.

Table 1 Quality of silica fume

Property		Criterion
Silicon dioxide	%	85.0 min.
Magnesium oxide	%	5.0 max.
Sulphur trioxide	%	3.0 max.
Free calcium oxide	%	1.0 max.
Free silicon	%	0.4 max.
Chloride ion ^{a)}	%	0.10 max.
Ignition loss	%	4.0 max.
Moisture content ^{b)}	%	3.0 max.
Specific surface area (BET method)	m ² /g	15 min.
Activity index ^{c)}	Material age 7 days	95 min.
	Material age 28 days	105 min.
Notes ^{a)} May be increased up to 0.30 % if approved by the purchaser. ^{b)} Applicable to powdery silica fume and granular silica fume. ^{c)} For air content of standard mortar and test mortar, the value measured by the manufacturer or the supplier shall be recorded in the test report.		

5.2 Silica fume slurry

The quality of solid in silica fume slurry, when the sample specified in clause 6 is tested according to clause 7, shall conform to the specification in Table 1. Further, the solid content of silica fume slurry, determined by the test specified in 7.12, shall not be outside the range between 0.96 times and 1.04 times the value stated by the manufacturer or the supplier.

The quality of the water used for preparation of silica fume slurry shall be in accordance with C.4 and C.5 of JIS A 5308.

6 Sample

6.1 Sampling

6.1.1 Powdery silica fume and granular silica fume

The samples shall be extracted so as to represent the average quality of the material tested and then shall be reduced.

6.1.2 Silica fume slurry

The samples of silica fume slurry shall be taken after thorough homogenization. The quantity of sampling, method of sampling and method of reduction shall be as agreed between the parties concerned with delivery.

6.2 Preparation

6.2.1 Powdery silica fume and granular silica fume

The preparation of samples shall be in accordance with clause 5 of JIS R 5201.

6.2.2 Silica fume slurry

For the preparation of a sample, if the silica fume used for the silica fume slurry is available, that silica fume shall be used. If it is not, silica fume slurry shall be used after being dried according to the method and procedure specified in **E.3**. However, for the test of solid content of silica fume slurry specified in **7.12**, silica fume slurry shall always be used.

7 Test methods

7.1 Silicon dioxide

The test of silicon dioxide shall be in accordance with one of the following.

- a) Annex F
- b) **JIS M 8853**
- c) Annex A of **JIS R 5202**

7.2 Magnesium oxide

The test of magnesium oxide shall be in accordance with one of the following.

- a) Annex F
- b) **JIS M 8853**
- c) Annex A of **JIS R 5202**

7.3 Sulphur trioxide

The test of sulphur trioxide shall be in accordance with one of the following.

- a) Annex F
- b) **JIS M 8853**
- c) Clause 12 of **JIS R 5202**

7.4 Free calcium oxide

The test of free calcium oxide shall be in accordance with Annex A.

7.5 Free silicon

The test of free silicon shall be in accordance with clause 9 of **JIS R 1616**.

7.6 Chloride ion

The test of chloride ion shall be in accordance with clause 18 of **JIS R 5202**.

7.7 Ignition loss

The test of ignition loss shall be in accordance with Annex B.

7.8 Moisture content

The test of moisture content shall be in accordance with Annex B.

7.9 Specific surface area