भारतीय मानक
Indian Standard

IS 16715 : 2018

वात्या भट्टी का अतिमहीन पिसा हुआ दानेदार धातुमल — विशिष्टि

Ultrafine Ground Granulated Blast Furnace Slag — Specification

ICS 91.100.01; 91.100.30

भारतीय मानक ब्यूरो
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September 2018 **Price Group 6**

Cement and Concrete Sectional Committee, CED 02

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Cement and Concrete Sectional Committee had been approved by the Civil Engineering Division Council.

The Indian Standard IS 12089 : 1987 'Specification for granulated slag for the manufacture of Portland slag cement' covers requirements for granulated slag. However, a need to have a separate standard on ultrafine ground granulated blast furnace slag, for various applications including in concrete, was felt. This standard on ultrafine ground granulated blast furnace slag (UGGBS) has, therefore, been formulated to fulfil this need. This product, when used with proper proportioning of concrete mix, can help improve the performance of concrete.

In the formulation of this standard, due weightage has been given to the International Standards and practices in different countries in addition to relating it to the practices in the field in this country.

This standard contains **7.2**, **7.2.1**, **7.3** and **7.4**, which call for agreement between the purchaser and the supplier.

The composition of the Committee responsible for the formulation of this standard is given in Annex D.

For ground granulated blast furnace slag, a separate Indian Standard, namely, IS 16715 : 2018 'Ground granulated blast furnace slag for use in cement, mortar and concrete — Specification' has been formulated.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

ULTRAFINE GROUND GRANULATED BLAST FURNACE SLAG — SPECIFICATION

1 SCOPE

This standard covers the manufacture, chemical and physical requirements, packing and storage of ultrafine ground granulated blast furnace slag.

2 REFERENCES

The standards listed in Annex A contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated in Annex A.

3 TERMINOLOGY

For the purpose of this standard, the following definitions shall apply.

3.1 Granulated Blast Furnace Slag

Blast furnace slag is a non-metallic product consisting essentially of glass containing silicates and alumino-silicates of lime and other bases, which is developed simultaneously with iron in blast furnace. Granulated blast furnace slag is obtained by further processing the molten slag by rapidly chilling or quenching with water or steam.

3.2 Ultrafine Ground Granulated Blast Furnace Slag (UGGBS)

It is granulated blast furnace slag duly ground and classified to specified particle size distribution so as to meet the requirements of this standard.

4 MANUFACTURE

UGGBS shall be manufactured by finely grinding granulated slag followed by classifying particles either by cyclone separator(s) or other suitable means so that the resulting product produces ultrafine granulated blast furnace slag complying with this standard. It shall not contain more than 1.0 percent of additives, not found harmful. If required, gypsum may also be added, such that the sulphate (SO_3) content is maintained within the prescribed requirements given in Table 1, and in such cases, the same shall be declared.

5 CHEMICAL REQUIREMENTS AND GLASS CONTENT

5.1 UGGBS shall comply with the chemical requirements given in Table 1.

Table 1 Chemical Requirement of UGGBS

(*Clauses* 4 *and* 5.1)

Sl No.	Constituent / Characteristic	Percent by Mass	Method of Test, Ref to
(1)	(2)	(3)	(4)
i)	Manganese oxide (MnO), *Max*	5.5	IS 4032
ii)	Magnesium oxide (MgO), *Max*	17.0	IS 4032
iii)	Sulphide sulphur (S), *Max*	2.0	IS 4032
iv)	Sulphate (as SO_3), *Max*	3.0	IS 4032
v)	Insoluble residue, *Max*	3.0	IS 4032
vi)	Chloride content, *Max*	0.1	IS 4032
vii)	Loss on ignition, *Max*	3.0	IS 4032
viii)	$\dfrac{CaO + MgO + \frac{1}{3} Al_2O_3}{SiO_2 + \frac{2}{3} Al_2O_3}$, *Min*	1.0	IS 4032
ix)	$\dfrac{CaO + MgO + Al_2O_3,}{SiO_2}$, *Min*	1.0	IS 4032
x)	$\dfrac{CaO + CaS + \frac{1}{2} MgO + Al_2O_3}{SiO_2 + MnO}$, *Min* (For granulated slag with > 2.5 percent MnO)	1.5	IS 4032

NOTE — For the purpose of testing of UGGBS as per IS 4032, wherever reference to cement has been made in IS 4032, it may be read as UGGBS.

Table 2 Physical Requirements of UGGBS

(*Clause* 6)

Sl No.	Characteristic	Requirement	Method of Test, Ref to
(1)	(2)	(3)	(4)
i)	Fineness, m^2/kg, *Min* BET Method (Nitrogen adsorption)	1 500	IS 11578
ii)	Particle size, µm, *Max:*		Using laser diffraction PSD analyzer
	a) D_{50}	5	
	b) D_{95}	15	
iii)	Slag activity index (*see* Note 2):		*See* Note 2
	a) 7 days	Not less than 60 percent	
	b) 28 days	Not less than 75 percent	

NOTES

1 D_{95} indicates that 95 percent of the particles on a mass basis are below a given size while D_{50} indicates that 50 percent of the particles on a mass basis are below a given size.

2 Slag activity index (SAI) shall be determined using blend of 50 percent UGGBS and 50 percent control OPC 43 conforming to IS 269, having total alkalies (Na_2O + 0.658 K_2O) not less than 0.6 percent and not more than 0.9 percent. The blend shall be tested for compressive strength by casting and testing prisms, in accordance with IS 4031(Part 8). The mortar mix proportions by mass are, 1 part of the cement blend under test, 3 parts of standard sand and 0.5 part of water.

SAI shall be determined as: $$\frac{\text{Compressive strength of the mortar cube using blend}}{\text{Compressive strength of control OPC mortar cube}} \times 100$$

5.2 The moisture content of UGGBS, when tested in accordance with the procedure given in Annex B, shall not exceed 1 percent by mass

5.3 The glass content of UGGBS shall not be less than 85 percent when determined by the method using optical microscope given in Annex C.

6 PHYSICAL REQUIREMENTS

UGGBS shall comply with the requirements given in Table 2.

7 PACKING

7.1 The UGGBS shall be packed in any of the following bags:

a) PP woven laminated block bottom valve sacks conforming to IS 16709,

b) Multi-wall paper sacks conforming to IS 11761,

c) HDPE/ PP woven sacks conforming to IS 11652,

d) Laminated jute sacking bag, or

e) Any other approved composite bag.

Bags shall be in good condition at the time of inspection.

7.2 The net quantity of UGGBS per bag shall be 50 kg or as mutually agreed to between the purchaser and the seller. It may also be supplied in drums or in bulk. In case of supply in bulk form, each consignment shall carry test certificate.

7.2.1 The tolerance on the quantity of UGGBS in each bag or consignment shall be ±1 percent or as mutually agreed upon between the purchaser and the supplier.

7.3 Supplies of ultrafine slag in bulk may be made by arrangement between the purchaser and the supplier (manufacturer or stockist).

NOTE — A single bag or container containing a quantity of 1 000 kg and more, shall be considered as the bulk supply of UGGBS. Supplies of UGGBS may also be made in intermediate containers, for example, drums of 200 kg, by agreement between the purchaser and the manufacturer.

7.4 When UGGBS is intended for export and if the purchaser so requires, packing of UGGBS may be done in bags or in drums with net quantity of UGGBS per bag or drum as agreed to between the purchaser and the manufacturer. The words 'FOR EXPORT' and the net quantity of UGGBS per bag/drum shall be clearly marked in indelible ink on each bag/drum. The packing material shall be as agreed to between the manufacturer and the purchaser; however, the packing should be adequate to comply with the environmental norms.

8 MARKING

8.1 Each bag/drum of UGGBS shall be legibly and indelibly marked with the following:

a) Manufacturer's name and his registered trade-mark;

b) The words ‘Ultrafine Ground Granulated Blast Furnace Slag’;
c) Net quantity, in kg;
d) The words ‘Use no Hooks’ on the bags;
e) Batch/control unit number in terms of week, month and year of packing; and
f) Address of the manufacturer.

8.2 Similar information shall be provided in the delivery advices accompanying the shipment of UGGBS in bulk form (*see* **7.3**).

8.3 BIS Certification Marking

The UGGBS may also be marked with the Standard Mark.

8.3.1 The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act*, 2016 and the Rules and Regulations made thereunder. The details of the conditions under which the licence for use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

9 SAMPLING

9.1 A sample or samples for testing may be taken by the purchaser or his representative, or by any person appointed to superintend the work for purpose of which the UGGBS is required or by the latter’s representative.

9.2 In addition to the requirements of **9.1**, the methods and procedure of sampling shall be in accordance with **5.1** to **5.7** of IS 3535.

NOTE — For the purpose of sampling, wherever reference to cement has been made in IS 3535, it may be read as UGGBS.

9.3 The samples shall be taken within three weeks of the delivery and all the tests shall be commenced within one week of sampling.

9.4 When it is not possible to test the samples within one week, the samples shall be packed and stored in air-tight containers till such time that they are tested not later than three months.

10 STORAGE

UGGBS shall be stored in silos free from the entry of moisture, and dampness, to minimize internal condensation. UGGBS packed in bags shall be kept away from ground contact to avoid damage.

11 CRITERIA FOR CONFORMITY

UGGBS sample drawn in accordance with **9** shall be tested and shall comply with all requirements of this standard.

12 TESTS

The sample or samples of UGGBS for tests shall be taken as per **9** and shall be tested in the manner prescribed in the relevant clauses.

13 TEST CERTIFICATE

The UGGBS supplier shall submit test certificate of each batch. The information provided in the test certificate shall comply with this standard and it shall contain compliance to all requirements as per this standard.

14 HEALTH AND SAFETY

Owing to its fineness, it is advisable to take all necessary precautions including the use of safety masks for breathing (*see* IS 9473) while handling and using the material.

ANNEX A

(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
269 : 2015	Ordinary Portland cement — Specification (*sixth revision*)
3535 : 1986	Methods of sampling hydraulic cement (*first revision*)
4031 (Part 8) : 1988	Methods of physical tests for hydraulic cement: Part 8 Determination of transverse and compressive strength of plastic mortar using prism (*first revision*)
4032 : 1985	Method of chemical analysis of hydraulic cement (*first revision*)
9473 : 2002	Respiratory protective devices — Filtering half masks to protect against particles — Specification (*first revision*)
11578 : 1986	Method for determination of specific surface area of powder and porous particle using low temperature gas adsorption techniques
11652 : 2017	Textiles — High density polyethylene (HDPE)/Polypropylene (PP) woven sacks for packaging of 50 kg cement — Specification (*third revision*)
11761 : 1997	Multi wall paper sacks for cement — Specification (*first revision*)
16709 : 2017	Textiles — Polypropylene (PP) woven, laminated, block bottom valve sacks for packaging of 50 kg cement — Specification

ANNEX B

(*Clause* 5.2)

METHOD FOR DETERMINATION OF MOISTURE CONTENT

B-1 PROCEDURE

Dry the clean empty Petri dish (approximately 100 mm diameter) at a temperature of 105°C to 110°C and weigh it, after cooling in a desiccator, spread uniformly, not less than 10 ± 0.5 g of UGGBS sample, as received basis, in this Petri dish and weigh. Heat this uncovered Petri dish with UGGBS in a drying oven at a temperature of 105°C to 110°C for 1 h. Cool the Petri dish with UGGBS in a desiccator and weigh. Repeat the process until there is no further loss in mass.

B-2 CALCULATION AND REPORTING OF RESULTS

Calculate the percentage of moisture to the nearest 0.1 percent as follows:

$$\text{Moisture content, percent} = \frac{x}{y} \times 100$$

where

x = loss in mass of UGGBS during drying; and

y = mass of UGGBS taken, as received basis.

ANNEX C

(*Clause* 5.3)

METHOD OF TEST FOR GLASS CONTENT

C-1 APPARATUS

C-1.1 Microscope

The microscope used for the purpose shall be polarizing microscope used generally for the examination of thin sections, and should have provision for mechanical stage and point counting. The magnifying power of the microscope shall not be less than 100 X.

C-2 REAGENT

C-2.1 Bromoform

Bromoform shall be of A.R or G.R grade chemical.

NOTE — Any other liquid having refractive index from 1.5 to 1.6 may also be used as an alternative to bromoform.

C-3 PROCEDURE

C-3.1 From about 5 g of a representative sample of UGGBS, a fraction passing through 90 µm IS Sieve and retained on 52 µm IS Sieve shall be treated as the sample for microscopic investigation as under **C-3.2.**

C-3.2 About 1 mg of UGGBS is placed on a rectangular glass slide and a cover glass having its size less than the width of the rectangular slide is placed on the material. One or two drops of bromoform or any other suitable liquid (*see* **C-2.1**) is added at the rim of the cover glass. It is seen that the liquid enters between the cover glass and glass slide. A gentle relative motion between the slide and cover glass shall be created to disperse the material evenly in the immersion liquid. No attempt shall be made to rub one slide over the other after the bromoform has been added. The powder immersion section is examined with transmitted light under the polarizing microscope at a magnification of about 200. About 1 500 grains are counted (N_1) by changing the field of view and traverses using a mechanical stage with the help of cross-wire in the eye piece. Subsequently under crossed nicols, the same field of view already scanned is examined once again in similar fashion and grains which appear anisotropic and opaque are counted (N_2).

C-4 CALCULATION

Calculate the glass content of UGGBS as follows:

$$\text{Glass content, percent} = \frac{(N_1 - N_2)}{N_1} \times 100$$

ANNEX D

(*Foreword*)

COMMITTEE COMPOSITION

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Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards: Monthly Additions'.

This Indian Standard has been developed from Doc No.: CED 02 (10872).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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Published by BIS, New Delhi