भारतीय मानक
Indian Standard

IS 16714 : 2018

सीमेंट, मोर्टार और कंक्रीट में उपयोग के लिए वात्या भट्टी का पिसा हुआ दानेदार धातुमल — विशिष्टि

Ground Granulated Blast Furnace Slag for Use in Cement, Mortar and Concrete — Specification

ICS 91.100.01

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Cement and ConcreteSectional 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, IS12089 : 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 ground slag suitable for use in Portland cement by blending process, and for making concrete by direct addition was felt. This new Indian standard on ground granulated blast furnace slag (GGBS) has, therefore, been formulated to fulfill this need.

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

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

GROUND GRANULATED BLAST FURNACE SLAG FOR USE IN CEMENT, MORTAR AND CONCRETE — SPECIFICATION

1 SCOPE

This standard covers manufacturing, chemical and physical requirements, storage and packing of ground granulated blast furnace slag to be used in the manufacture of cement, and as mineral admixture in mortar and concrete making.

2 REFERENCES

The standards given 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 Ground Granulated Blast furnace Slag (GGBS)

It is granulated blast furnace slag duly ground so as to meet the requirements of this standard.

4 MANUFACTURE

GGBS shall be manufactured by drying and grinding of granulated blast furnace slag. It may contain not more than 1.0 percent of additives not found harmful, for the purpose of improving its surface characteristics.

5 CHEMICAL REQUIREMENTS AND GLASS CONTENT

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

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

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

6 PHYSICAL REQUIREMENTS

GGBS shall comply with the physical requirements given in Table 2.

7 PACKING

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

a) Jute sacking bag conforming to IS 2580,
b) Multi-wall paper sacks conforming to IS 11761,
c) HDPE/PP woven sacks conforming to IS 11652, or
d) Any other approved composite bag.

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

7.2 The net quantity of GGBS 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 GGBS in each bag or consignment shall be ±1 percent or as mutually agreed upon between the purchaser and the supplier.

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

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

7.4 When the GGBS is intended for export and if the purchaser so requires, packing of the GGBS may be done in bags or in drums with net quantity of GGBS per bag or drum as agreed to between the purchaser and the manufacturer. The words 'FOR EXPORT' and

Table 1 Chemical Requirements of GGBS
(*Clause* 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)	$\frac{CaO+MgO+1/3AlO_3}{SiO_2+2/3\ AlO_3}$, *Min*	1.0	IS 4032
ix)	$\frac{CaO+MgO+Al_2O_3}{SiO_2}$, *Min*	1.0	IS 4032
x)	$\frac{CaO+CaS+1/2\ MgO+Al_2O_3}{SiO_2+MnO}$, *Min*	1.5	IS 4032
	(For granulated slag with > 2.5 percent MnO)		

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

the net quantity of GGBS 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, packing should be adequate to comply with environmental norms.

8 MARKING

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

a) Manufacturer's name and his registered trade-mark;
b) The words '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 GGBS in bulk form (*see* **7.3**).

8.3 BIS Certification Marking

The GGBS 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*, 1986 and the Rules and Regulations made thereunder. The details of conditions under which a license for the 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 the purpose of which the GGBS 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 GGBS.

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

GGBS shall be stored in silos protected from entry of moisture and free from dampness to minimize internal

Table 2 Physical Requirements of GGBS

(*Clause* 6)

Sl No.	Constituent	Requirement	Method of Test, Ref to
(1)	(2)	(3)	(4)
i)	Fineness, m^2/kg, *Min*	320	IS 4031 (Part 2) (*see* Note 1)
ii)	Slag activity index (*see* Note 2) :		
	a) 7 days	Not less than 60 percent of control OPC 43 Grade cement mortar cube	–
	b) 28 days	Not less than 75 percent of control OPC 43 Grade cement mortar cube	–

NOTES

1 For the purpose of testing of GGBS as per IS 4031 (Part 2), wherever reference to cement has been made in IS 4031 (Part 2), it may be read as GGBS.

2 Slag activity index (SAI) shall be determined using blend of 50 percent GGBS 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 in accordance with IS 4031 (Part 6), for determining compressive strength of mortar.
SAI shall be determined as:

$$\frac{\text{Compressive strength of the mortar cube using blend}}{\text{Compressive strength of control OPC mortar cube}} \times 100$$

condensation. GGBS packed in bags shall be kept away from ground contact to avoid damage.

11 CRITERIA FOR CONFORMITY

GGBS 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 GGBS for tests shall be taken as per **9** and shall be tested in the manner prescribed in the relevant clauses.

13 TEST CERTFICATE

GGBS supplier shall submit test certificate of each batch. The information provided in the test certificate shall comply with this standard and it shall cover all the requirements of this standard.

ANNEX A

(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*	*IS No.*	*Title*
269 : 2015	Ordinary Portland cement Specification (*sixth revision*)	(Part 6) : 1988	Determination of compressive strength of hydraulic cement other than masonry cement (*first revision*)
2580 : 1995	Textiles — Jute sacking bags for packing cement — Specification (*third revision*)	4032 : 1985	Method of chemical analysis of hydraulic cement (*first revision*)
3535 : 1986	Methods of sampling hydraulic cement (*first revision*)	11652 : 2017	Specification for woven sacks for packing cement — High density polyethylene (HDPE)/Polypropylene (PP) (*third revision*)
4031	Methods of physical tests for hydraulic cement		
(Part 2) : 1999	Determination of fineness by Blaine air permeability method (*second revision*)	11761 : 1997	Specification for multi wall paper sacks for cement (*first revision*)

ANNEX B

(*Clause* 5.2)

METHOD OF TEST 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 GGBS sample, as received basis, in this Petri dish and weigh. Heat this uncovered Petri dish with GGBS in a drying oven at a temperature of 105°C to 110°C for 1 h. Cool the Petri dish with heated GGBS 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 GGBS during drying; and

y = mass of GGBS 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 ×.

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 GGBS, 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 1mg of GGBS 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 GGBS as follows:

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

ANNEX D

(*Foreword*)

COMMITTEE COMPOSITION

Cement and Concrete Sectional Committee, CED 02

Organization	*Representative(s)*
In Personal Capacity, (*14A, Summer Breeze, Seasons, Kuravankonam, Kowdiar, Thiruvananthapuram 6950 03*)	Shri Jose Kurian (***Chairman***)
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