भारतीय मानक
Indian Standard

IS 16993 : 2018

माइक्रोफाइन साधारण पोर्टलैंड सीमेंट — विशिष्टि

Microfine Ordinary Portland Cement — Specification

ICS 91.100.10

भारतीय मानक ब्यूरो
BUREAU OF INDIAN STANDARDS
मानक भवन, 9 बहादुरशाह ज़फर मार्ग, नई दिल्ली – 110002
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI-110002
www.bis.gov.in www.standardsbis.in

September 2018 **Price Group 7**

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.

Ordinary Portland cement (OPC) in India is available in various grades. The fineness of OPC is specified in term of minimum fineness as determined by Blaine air permeability method. However, the prescribed fineness might not be sufficient for certain specialized application of grouting and repairs for leak prevention.

This standard has therefore been brought out to prescribe the various characteristics and properties of microfine OPC for special applications like rock grouting, grouting concrete structures and underground construction for leak prevention, soil stabilization, etc. This also covers requirements for microfine sulphate resisting Portland cement.

In the formulation of this standard due weightage has been given to international co-ordination among the standards and practices prevailing in different countries in addition to relating it to the practices in the field in this country.

This standard contains **8**, **9.2**, **9.3, 12.2.1** and Annex D, 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 E.

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

MICROFINE ORDINARY PORTLAND CEMENT — SPECIFICATION

1 SCOPE

1.1 This standard covers the manufacture and chemical and physical requirements for microfine ordinary Portland cement.

1.2 This standard also covers requirements for microfine sulphate resisting Portland cement.

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 definitions given in IS 4845, and the following shall apply.

3.1 Microfine Ordinary Portland Cement — Ground and classified Portland cement meeting the specified particle size distribution and other requirements as per this standard.

4 MANUFACTURE

The microfine cement shall be manufactured by intimately mixing calcareous or argillaceous materials and/or other silica, alumina or iron oxide bearing materials, burning them at a clinkering temperature and grinding the resultant clinker, or by grinding the clinker conforming to IS 16353 so as to produce a cement capable of complying with this standard. No material other than gypsum (natural or chemical), water and not more than 5.0 percent additives, which have proved not to be harmful, shall be added during grinding of the cement. Otherwise, ordinary Portland cement conforming to IS 269 may be ground and processed to manufacture microfine cement complying with this standard. This is followed by separating the desired particles size by cyclone separator or by a suitable separator system.

5 CHEMICAL REQUIREMENTS

When tested in accordance with the methods given in IS 4032, microfine cement shall comply with the chemical requirements given in Table 1.

6 PHYSICAL REQUIREMENTS

Microfine cement shall comply with the requirements given in Table 2.

7 STORAGE

The microfine cement shall be stored in such a manner as to permit easy access for proper inspection and identification, and in a suitable weather-tight building to protect the microfine cement from dampness and to minimize warehouse deterioration (*see also* IS 4082).

8 MANUFACTURER'S CERTIFICATE

8.1 The manufacturer shall satisfy himself that the microfine cement conforms to the requirements of this standard and, if requested, shall furnish a test certificate to this effect to the purchaser or his representative, within ten days of testing of the microfine cement (except for 28 days compressive strength test results, which shall be furnished after completion of the test).

8.2 The manufacturer shall furnish a certificate indicating the alkali content, if requested.

9 PACKING

9.1 The microfine cement 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, or
d) Laminated jute sacking bag, or
e) Any other approved composite bag.

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

9.1.1 The net quantity of microfine cement per bag shall be 50 kg subject to provisions and tolerance given in Annex D.

Table 1 Chemical Requirements for Microfine Ordinary Portland Cement

(*Clause* 5.1)

Sl No.	Characteristic	Requirement
(1)	(2)	(3)
i)	Ratio of percentage of lime to percentages of silica, alumina and iron oxide, when calculated by the formula: $\frac{CaO - 0.7\ SO_3}{2.8\ SiO_2 + 1.2\ Al_2O_3 + 0.65\ Fe_2O_3}$	0.80 – 1.02
ii)	Ratio of percentage of alumina to that of iron oxide, *Min* (*see* Note 1)	0.66
iii)	Insoluble residue, percent by mass, *Max*	5.0
iv)	Magnesia, percent by mass, *Max*	6.0
v)	Total sulphur content calculated as sulphuric anhydride (SO_3), percent by mass, *Max*	3.5
vi)	Loss on ignition, percent by mass, *Max*	4.0
vii)	Chloride content, percent by mass, *Max*	0.1
viii)	Alkali content	*See* Note 2
ix)	Additional requirements for microfine sulphate resisting Portland cement:	
	a) Tricalcium aluminate (C_3A) percent by mass (*See* Note 3), *Max*	5
	b) Tetracalcium alumino ferrite phase plus twice the tricalcium aluminate ($C_2AF + 2C_2A$), percent by mass (*see* Note 3), *Max*	25

NOTES

1 This requirement is not applicable in case of microfine sulphate resisting Portland cement (*see also* Note 3).

2 Alkali aggregate reactions have been noticed in aggregates in some parts of the region. On large and important jobs where the concrete is likely to be exposed to humid atmosphere or wetting action, it is advisable that the aggregate be tested for alkali aggregate reaction. In the case of reactive aggregates, the use of microfine cement with alkali content below 0.6 percent expressed as sodium oxide (Na_2O+ 0.658 K_2O), is recommended. Where, however, such cements are not available, use of alternative means may be resorted to for which a reference may be made to appropriate provisions on durability in the concrete codes. If so desired by the purchaser, the manufacturer shall carry out test for alkali content.

3 The tricalcium aluminate and tetracalcium alumino ferrite content are calculated by the following formulae:

$$C_3A = 2.65\ Al_2O_3 - 1.69\ Fe_2O_3$$

$$C_4AF = 3.043\ Fe_2O_3$$

When the alumina-ferric oxide ratio is less than 0.64 (hence C_3A is absent), a calcium alumino ferrite solid solution expressed as *SS* ($C_4AF + C_2F$) is formed. Contents of this solid solution and of tricalcium silicate shall be calculated by the following formulae:

$$SS\ (C_4AF + C_2F) = (2.100\ Al_2O_3) + (1.702\ Fe_2O_3)$$

$$C_2S = (4.071\ CaO) - (7.600\ SiO_2) - (4.479\ Al_2O_3) - (2.859\ Fe_2O_3) - (2.852\ SO_2)$$

4 When expressing compounds, certain symbols have been used, namely, C = CaO, S = SiO_2, A = Al_2O_3, and F = Fe_2O_3. For example, C_3A = 3CaO.Al_2O_3. Titanium dioxide and phosphorous pentoxide (TiO_2 and P_2O_5 shall be included with the Al_2O_3 content. The value historically and traditionally used for Al_2O_3 in calculating potential compounds for specification purposes is the ammonium hydroxide group minus ferric oxide ($R_2O_3 - Fe_2O_3$) as obtained by classical wet chemical methods. This procedure includes as Al_2O_3 the TiO_2, P_2O_5 and other trace oxides which precipitate with the ammonium hydroxide group in the classical wet chemical methods. Many modern instrumental methods of cement analysis determine aluminium or aluminium oxide directly without the minor and trace oxide included as in the classical method. Consequently, for consistency and to provide comparability with historic data and among various analytical methods, when calculating potential compounds for specification purposes, those using methods which determine Al or Al_2O_3 directly should add to the determined Al_2O_3 mass quantities of P_2O_5, TiO_2 and any other oxide except Fe_2O_3 which would precipitate with the ammonium hydroxide group when analyzed by the classical method and which is present in an amount of 0.05 percent by mass or greater. The percentage (by mass) of minor or trace oxides to be added to Al_2O_3 by those using direct methods may be obtained by actual analysis of those oxides in the sample being tested or estimated from historical data on those oxides on cements from the same source, provided that the estimated values are identified as such.

Table 2 Physical Requirements of Microfine Ordinary Portland Cement

(*Clause* 6)

Sl No.	Characteristic	Requirement	Method of Test, Ref to
(1)	(2)	(3)	(4)
i)	Fineness, m^2/kg, *Min*	2 000	IS 11578
	BET method (Nitrogen adsorption)		
ii)	Particle size, µm, *Max :*		Using laser diffraction PSD analyzer
	a) D_{50}	10	
	b) D_{95}	20	
iii)	Setting time :		Annex B
	a) Initial setting time, h, *Min*	1	
	b) Final setting time, h, *Max*	20	
iv)	Bleeding test at 3 h from the time of mixing, percent, *Max*	5	Annex C
v)	Compressive strength, MPa (*see* Notes 2 and 3) :		IS 4031 (Part 8)
	a) 3 days, *Min*	16	
	b) 7 days, *Min*	22	
	c) 28 days, *Min*	33	

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 For compressive strength test, microfine cement and standard sand in the ratio of 1:3 and water cement ratio of 0.5 shall be used.

In case the mix is found to be harsh and does not have the plastic consistency required for proper compaction, required quantity of superplasticizers conforming to IS 9103 may be added for proper workability and mixing. The type and dosage of super plasticizer, if added, may be reported.

3 Notwithstanding the strength requirements, the compressive strength shall show a progressive increase in strength specified at 3 day.

9.2 The net quantity of microfine cement per bag may also be 25 kg, 10 kg, 5 kg, 2 kg or 1 kg and packed in suitable bags as agreed to between the purchaser and the manufacturer but the bag shall be of the material and quality as given in with **9.1**. The quantity of microfine cement in the bags shall also be subject to tolerances as given in Annex D for 50 kg bags.

9.3 Supplies of microfine cement in drums or in bulk may be made by arrangement between the purchaser and the supplier (manufacturer or stockist).

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

9.4 When microfine cement is intended for export and if the purchaser so requires, packing of microfine cement may be done in bags or in drums with net quantity of microfine cement per bag or drum as agreed to between the purchaser and the manufacturer.

9.4.1 For this purpose, the permission of the certifying authority shall be obtained in advance for each export order.

9.4.2 The words ‘FOR EXPORT’ and the net quantity of microfine cement 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. The tolerance requirements for the quantity of microfine cement packed in bags/drum shall be as given in **9.2.1** except the net quantity which shall be equal to or more than the quantity in **9.3**.

10 MARKING

10.1 Each bag or drum of microfine cement shall be legibly and indelibly marked with the following:

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

b) The words ‘Microfine Ordinary Portland Cement’ or ‘Microfine Sulphate Resisting Portland Cement’, as the case may be;

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;

f) Address of the manufacturer; and

g) The need for testing of microfine cement more than 3 months old to check conformity before its use.

10.2 Similar information shall be provided in the delivery advices accompanying the shipment of packed or bulk microfine cement and on microfine cement drums (*see* **9.3**).

10.3 BIS Certification Marking

The microfine cement may also be marked with the Standard Mark.

10.3.1 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.

11 SAMPLING

11.1 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 microfine cement is required or by the latter's representative.

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

11.1.2 When it is not possible to test the samples within one week, the samples shall be packed and stored in air-tight containers and tested at the earliest but not later than 3 months since the receipt of samples for testing.

11.2 In addition to the requirements of **11.1**, the methods and procedure of sampling shall be in accordance with IS 3535.

11.3 The manufacturer or the supplier shall afford every facility, and shall provide all labour and materials for taking and packing the samples for testing the microfine cement and for subsequent identification of microfine cement sampled.

12 TESTS

12.1 The sample or samples of microfine cement for test shall be taken as described in **11** and shall be tested in the manner described in the relevant clauses.

12.2 Independent Testing

12.2.1 If the purchaser or his representative requires independent tests, the samples shall be taken before or immediately after delivery as the option of the purchaser or his representative and the tests shall be carried out in accordance with this standard on the written instructions of the purchaser or his representative.

12.2.2 The manufacturer shall supply, free of charge, the microfine cement required for testing. Unless otherwise specified in the enquiry and order, the cost of the tests shall be borne as follows:

a) By the manufacturer if the results show that the microfine cement does not comply with the requirements of this standard, and

b) By the purchaser if the results show that the microfine cement complies with the requirements of this standard.

12.2.3 After a representative sample has been drawn, tests on the sample shall be carried out as expeditiously as possible (*see* **11.1.1** and **11.1.2**).

13 REJECTION

13.1 Microfine cement may be rejected, if it does not comply with any of the requirements of this specification.

13.2 Microfine cement remaining in bulk storage at the mill, prior to shipment, for more than six months, or microfine cement in bags, in local storage in the hands of a vendor for more than 3 months after completion of tests, may be retested before use and may be rejected, if it fails to conform to any of the requirements of this specification.

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*)
4082 : 1996	Stacking and storage of construction materials and components at site — Recommendations (*second revision*)
4845 : 1968	Definitions and terminology relating to hydraulic cement
4905 : 2015/ ISO 24153 : 2009	Random sampling and randomization procedures (*first revision*)
9103 : 1999	Concrete admixtures — 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*)
16353 : 2015	Portland cement clinker — Specification
16709 : 2017	Textiles — Polypropylene (PP) woven, laminated, block bottom valve sacks for packaging of 50 kg cement — Specification

ANNEX B

(*Table* 2)

DETERMINATION OF INITIAL AND FINAL SETTING TIME TEST FOR MICROFINE CEMENT

B-1 The objective is to determine the initial and final setting time, a grout is prepared with 1 : 1 ratio of water to microfine cement.

B-2 TEST PROCEDURE

The laboratory in which test is carried out shall be maintained at a temperature of 27 ± 2°C and a humidity of not less than 65 percent.

Fill the prepared grout in the Vicat mould completely and level the top surface. Place the above mould under the rod bearing needle. Use initial setting time needle of 0.5 mm diameter. Gently lower the needle until it comes in contact with the surface of the test block and release quickly. Repeat the above until the needle fails to penetrate the block beyond 5 ± 0.5 mm measured from the bottom of the mould. Record the initial setting time as the period elapsing between the time when water is added and the time at which the needle fails to penetrate the test block to a point 5 ± 0.5 mm from the bottom. For determination of final setting time, replace the needle of Vicat apparatus by the needle with an annular attachment. The microfine cement shall be considered as finally set when, upon applying the needle gently to the surface of test block, the needle makes an impression thereon, while the attachment fails to do so. Record the final setting time as the period elapsing between the time when water is added and the time at which the needle makes an impression, while the annular attachment fails to do so.

ANNEX C

(*Table* 2)

DETERMINATION OF PERCENTAGE BLEED WATER OF PORTLAND MICROFINE CEMENT

C-1 The objective is to determine the percentage bleed water of specimen with 1 part microfine cement and one part water; or a water content equivalent to that of Marsh cone flow test; whichever is greater (*see* Note).

NOTE — **MARSH CONE FLOW**

Water addition shall be adjusted so as to get marsh cone flow of 30 to 40 seconds or as per agreed between manufacture and purchaser to suit the site requirements. Manufacturer shall declare the requirement of water addition to get marsh cone flow of 30 s to 40 s.

Description of Marsh Funnel and Method for Determination of Fluidity of Grout Slurry

Description of Marsh Funnel

A Marsh funnel as shown in Fig. 1 having a diameter of 150 mm at the top and a height of 300 mm, the bottom orifice outlet having an inside diameter of about 5 mm. The top of the cone has a screen with 1.5 mm openings, for screening out lumps of poorly mixed slurry.

Method

Pour 2 000 ml of slurry into the funnel. Record the time taken for 1 000 ml of the slurry to pass through the funnel into the measuring cylinder. The result to the nearest second is the Marsh funnel viscosity. For clear water at 21°C, the Marsh funnel viscosity is 27 s. For grout slurries, the marsh funnel viscosity has a good relationship with viscosity in centipoise determined by a rotational viscometer. The relationship is nearly straight line in the range of 30-40 s. This can be developed for each individual microfine cement mix.

C-2 TEST PROCEDURE

The laboratory in which test is carried out shall be maintained at temperature of 27 ± 2°C and humidity not less than 65 percent.

Fill the prepared specimen in a 1 000 ml measuring cylinder up to the level of 700 ml and leave as it is.

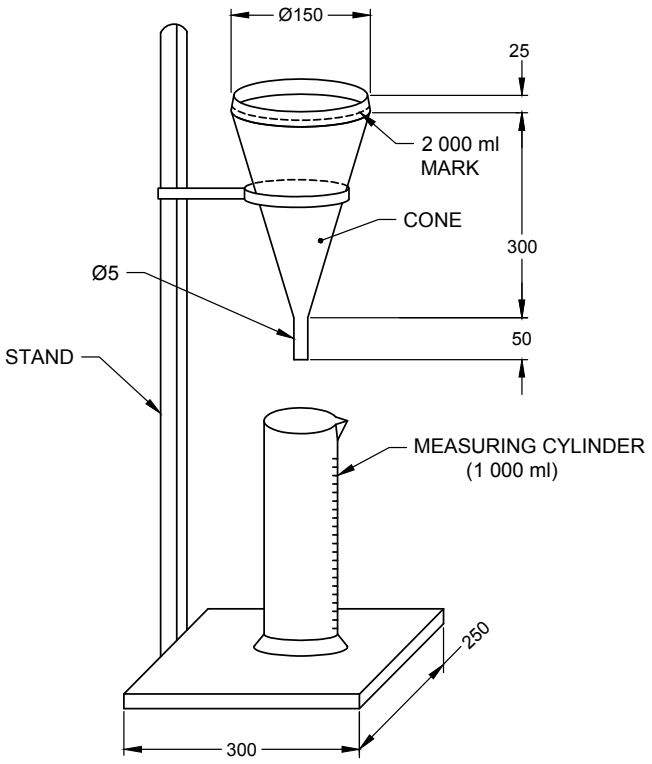
After 3 h, measure the volume of bleed water above the specimen. Calculate the percentage bleed water as follows:

$$\text{percentage bleed water} = (V_1 / V) \times 100$$

where

V_1 = Volume of bleed water, and

V = Specimen volume, as 700 ml.



All dimensions in millimetres.

FIG.1 MARSH FUNNEL

ANNEX D

(*Foreword and Clause* 9.1.1)

TOLERANCE REQUIREMENTS FOR THE QUANTITY OF MICROFINE CEMENT PACKED IN BAGS

D-1 The average of the net quantity of microfine cement packed in bags at the plant in a sample shall be equal to or more than 50 kg. The number of bags in a sample shall be as given below:

Batch Size	*Sample Size*
100 – 150	20
151 – 280	32
281 – 500	50
501 – 1 200	80
1 201 – 3 200	125
3 201 and over	200

The bags in a sample shall be selected at random. For methods of random sampling, IS 4905 may be referred to.

D-1.1 The number of bags in a sample showing a minus error greater than 2 percent of the specified net quantity (50 kg) shall be not more than 5 percent of the bags in the sample. Also the minus error in none of such bags in a sample shall exceed 4 percent of the specified net quantity of microfine cement in the bag.

D-1.2 In case of a wagon/truck load of up to 25 tonne, the overall tolerance on net quantity of microfine cement shall be 0 to 0.5 percent.

NOTE — The mass of a 6-ply paper bag to hold 50 kg of microfine cement is approximately 400 g, the mass of a PP block bottom woven sack to hold 50 kg of microfine cement is approximately 82 g, the mass of a HDPE/ PP woven sack to hold 50 kg of microfine cement is approximately 70 g/71 g respectively, and the mass of a jute synthetic union bag to hold 50 kg of microfine cement is approximately 420 g.

ANNEX E

(*Foreword*)

COMMITTEE COMPOSITION

Cement and Concrete Sectional Committee , CED 02

Organization	*Representative(s)*
In Personal Capacity, (*14A, Summer Breeze, Seasons, Kuravankonam, Kowdiar, Thiruvananthapuram 695 003*)	Shri Jose Kurian (***Chairman***)
ACC Ltd, Mumbai	Shri S. A. Khadilkar Shri Raman Sadanand Parulekar (*Alternate*)
Ambuja Cements Limited, Ahmedabad	Shri J. P. Desai Dr Bibekananda Mohapatra (*Alternate*)
Atomic Energy Regulatory Board, Mumbai	Shri L. R. Bishnoi Shri Sourav Acharya (*Alternate*)
Builders' Association of India, Mumbai	Shri Sushanta Kumar Basu Shri D. R. Sekor (*Alternate*)
Building Materials and Technology Promotion Council, New Delhi	Shri J. K. Prasad Shri C. N. Jha (*Alternate*)
Cement Manufacturers' Association, Noida	Shri Rakesh Bhargava Dr S. K. Handoo (*Alternate*)
Central Public Works Department, New Delhi	Shri A. K. Garg Shri Rajesh Khare (*Alternate*)
Central Water Commission, New Delhi	Director (CMDD) (N&W) Deputy Director (CMDD) (NW&S) (*Alternate*)
Conmat Technolgies Pvt Ltd, Kolkata	Dr A. K. Chatterjee Shri Subrato Chowdhury (*Alternate*)
Construction Chemical Manufacturers' Association, Mumbai	Shri Samir Surlaker Shri Nilotpol Kar (*Alternate*)
CSIR-Central Building Research Institute, Roorkee	Shri S. K. Singh Shri Subhash Gurram (*Alternate*)
CSIR-Central Road Research Institute, New Delhi	Shri J. B. Sengupta Shri Satish Pandey (*Alternate*)
CSIR-Structural Engineering Research Centre, Chennai	Dr K. Ramanjaneyulu Dr P. Srinivasan (*Alternate*)
Central Soil and Materials Research Station, New Delhi	Director Shri N. Siva Kumar (*Alternate*)
Delhi Development Authority, New Delhi	Shri Laxman Singh Shri Vijay Shankar (*Alternate*)
Engineers India Limited, New Delhi	Shri Rajanji Srivastava Shri Anurag Sinha (*Alternate*)
Department of Science and Technology, Ministry of Science and Technology, New Delhi	Shri Chander Mohan
Gammon India Limited, Mumbai	Shri V. N. Heggade Shri S. C. Upadhyay (*Alternate*)
Hindustan Construction Company Ltd, Mumbai	Shri Satish Kumar Sharma Dr Chetan Hazaree (*Alternate*)

Organization	*Representative(s)*
Housing and Urban Development Corporation Limited, New Delhi	Shri Deepak Bansal
Indian Association of Structural Engineers, New Delhi	Shri Mahesh Tandon Shri Ganesh Juneja (*Alternate*)
Indian Concrete Institute, Chennai	Shri Vivek Naik Secretary General (*Alternate*)
Indian Institute of Technology Delhi, New Delhi	Dr Shashank Bishnoi Dr Supratic gupta (*Alternate*)
Indian Institute of Technology Madras, Chennai	Prof Devdas Menon Dr Manu Santhanam (*Alternate*)
Indian Institute of Technology Roorkee, Roorkee	Prof V. K. Gupta Dr Bhupinder Singh (*Alternate*)
Indian Roads Congress, New Delhi	Secretary General Director (*Alternate*)
Institute for Solid Waste Research & Ecological Balance, Visakhapatnam	Dr N. Bhanumathidas Shri N. Kalidas (*Alternate*)
Military Engineer Services, E-in-C's Branch, Army HQ, New Delhi	Maj Gen S. K. Srivastav Shri Man Singh (*Alternate*)
Ministry of Road Transport & Highways, New Delhi	Shri A. P. Pathak Shri A. K. Pandey (*Alternate*)
National Council for Cement and Building Materials, Ballabgarh	Shri V. V. Arora Dr S. Harsh (*Alternate*)
National Test House, Kolkata	Shri Shir Singh Shrimati S. A. Kaushil (*Alternate*)
Nuclear Power Corporation of India Ltd, Mumbai	Shri Arvind Shrivastava Shri Raghupati Roy (*Alternate*)
Nuvoco Vistas Corporation Limited, Mumbai	Shri Pranav Desai Shri Ravindra khamparia (*Alternate*)
OCL India Limited, New Delhi	Dr S. C. Ahluwalia
Public Works Department, Government of Tamil Nadu, Chennai	Superintending Engineer Executive Engineer (*Alternate*)
The India Cements Limited, Chennai	Dr D. Venkateswaran
The Indian Hume Pipe Company Limited, Mumbai	Shri P. R. Bhat Shri S. J. Shah (*Alternate*)
The Institution of Engineers (India), Kolkata	Dr H. C. Visvesvaraya Shri S. H. Jain, (*Alternate*)
The Ramco Cements Ltd, Chennai	Shri Balaji K. Moorthy Shri Anil Kumar Pillai (*Alternate*)
Ultra Tech Cement Ltd, Mumbai	Shri Surya Valluri Dr M. R. Kalgal (*Alternate*)
Voluntary Organization in Interest of Consumer Education, New Delhi	Shri M. A. U. Khan Shri B. Mukhopadhyay (*Alternate*)
In personal capacity (*E-1, 402 White House Apartments R. T. Nagar, Bengaluru*)	Shri S. A. Reddi
In personal capacity [*B-806, Oberoi Exquisite Oberoi Garden City, Goregaon (East), Mumbai*]	Shri A. K. Jain

Organization	*Representative(s)*
In personal capacity (*36, Old Sneh Nagar Wardha Road, Nagpur*)	Shri L. K. Jain
In personal capacity (*EA-92, Maya Enclave Hari Nagar, New Delhi*)	Shri R. C. Wason
BIS Directorate General	Shri Sanjay Pant, Scientist ' F' and Head (Civil Engg) [Representing Director General (*Ex-officio*)]

Member Secretary

Shrimati Divya S
Scientist 'B' (Civil Engg), BIS

Cement, Pozzolana and Cement Additives Subcommittee, CED 2 : 1

Organization	*Representative(s)*
In Personal Capacity (*Type IV/17, President's Estate, New Delhi 110 004)*	Shri K. H. Babu (***Convener***)
20 Microns Limited, Mumbai	Shri Atil Parikh Shri Sunil Mistry (*Alternate*)
ACC Ltd, Mumbai	Shri S. A. Khadilkar Shri Raman Sadanand Parulekar (*Alternate*)
AIMIL Ltd, New Delhi	Dr V. M. Sharma Shri Aman Khullar (*Alternate*)
Ambuja Cements Ltd, Ahmedabad	Shri J. P. Desai Dr Bibekananda Mohapatra (*Alternate*)
Building Materials and Technology Promotion Council, New Delhi	Shri J. K. Prasad Shri C. N. Jha (*Alternate*)
Cement Corporation of India Ltd, New Delhi	Shrimati Saraswathi Devi Shrimati Bibha Kumari (*Alternate*)
Cement Manufacturers' Association, Noida	Dr D. Venkateswaran Shri S. K. Saxena (*Alternate*)
Central Electricity Authority, New Delhi	Shri Y. K. Sharma Shri Mohan Kumar (*Alternate*)
Central Pollution Control Board, Delhi	Shri J. S. Kamyotra Shri P. K. Gupta (*Alternate*)
Central Public Works Department, New Delhi	Shri A. K. Garg Shri Rajesh Khare (*Alternate*)
CSIR-Central Building Research Institute, Roorkee	Shri S. K. Singh Shri Micky M. Delbehra (*Alternate*)
CSIR-Central Road Research Institute, New Delhi	Shri J. B. Sengupta Shri Satish Pandey (*Alternate*)
Central Soil and Materials Research Station, New Delhi	Shr N. Siva Kumar Shri N. V. Mahure (*Alternate*)
Dalmia Cement (Bharat) Limited, New Delhi	Shri Prateek Gaur Shri Shashi Bhushan (*Alternate*)
Department of Science and Technology, Ministry of Science and Technology, New Delhi	Shri Chander Mohan

Organization	*Representative(s)*
Elkem South Asia Pvt Ltd, Navi Mumbai	Shri Brajesh Malviya Shri Surendra Sharma (*Alternate*)
Gammon India Limited, Mumbai	Shri Avinash Y. Mahendrakar Shri Manish Mokal (*Alternate*)
Gujarat Engineering Research Institute, Vadodara	Shri Rameshchandra H Fefar Shri Umesh C Shukla (*Alternate*)
Hindustan Construction Company Limited, Mumbai	Shri Avinash Harde Dr Chetan Hazaree (*Alternate*)
Indian Concrete Institute, Chennai	Dr Anant M. Pande Secretary General (*Alternate*)
Indian Institute of Technology Delhi, New Delhi	Dr Shashank Bishnoi Dr Supratic Gupta (*Alternate*)
Institute for Solid Waste Research & Ecological Balance, Visakhapatnam	Dr N. Bhanumathidas Shri N. Kalidas (*Alternate*)
JSW Cement Limited, Mumbai	Shri Pushp Raj Singh Shrimati Lopamudra Sengupta (*Alternate*)
Maharashtra Engineering Research Institute, Nasik	Scientific Research Officer Assistant Research Officer (*Alternate*)
Military Engineer Services, Engineer-in-Chief Branch, Army HQ, New Delhi	Brig S. B. Vajramatti Shri Subodh Kumar (*Alternate*)
Ministry of Commerce & Industry, New Delhi	Industrial Adviser Senior Development Officer (*Alternate*)
National Council of Cement and Building Materials, Ballabgarh	Dr S. Harsh Shri S. K. Chaturvedi (*Alternate*)
National Hydrolectric Power Corporation Limited, Faridabad	Shri A. K. Jain
National Test House, Kolkata	Shri D. V. S. Prasad Dr Moitrayee Devi (*Alternate*)
NTPC Ltd, New Delhi	Deputy General Manager (PE-Civil) Shri Masoom Ali (*Alternate*)
Nuvoco Vistas Corporation Limited, Mumbai	Shri Pranav Desai Shri Ravindra Khamparia (*Alternate*)
Public Works Department, Govt of Tamil Nadu, Chennai	Joint Chief Engineer (Irrigation) Executive Engineer (*Alternate*)
Ready Mixed Concrete Manufacturers' Association, Mumbai	Shri Vijaykumar R. Kulkarni
Tamil Nadu Minerals Limited, Chennai	Shri M. Boopathy Shri S. Kannadasan (*Alternate*)
Tata Steel Ltd, Jamshedpur	Shri A. S. Reddy Shri Vipul Mohan Koranne (*Alternate*)
The Ramco Cements Ltd, Chennai	Shri Balaji K. Moorthy Shri Anil Kumar Pillai (*Alternate*)
Ultra Tech Cement Ltd, Mumbai	Dr A. K. Singh Shri A. K. Tiwari (*Alternate*)

Panel for Revision of Cement Standards, CED 2 : 1/P1

Organization	*Representative*(*s*)
In Personal Capacity (*Type IV/17, President's Estate, New Delhi 110 004)*	Shri K. H. Babu (***Convener***)
AIMIL Ltd, New Delhi	Dr V. M. Sharma Shri Aman Khullar (*Alternate*)
Cement Manufacturers' Association, Noida	Dr D. Venkateswaran Shri R. K. Kamparia (*Alternate*)
Central Public Works Department, New Delhi	Shri D. K. Garg Shri Rajesh Khare (*Alternate*)
CSIR-Central Building Research Institute, Roorkee	Dr A. K. Minocha Dr Neeraj Jain (*Alternate*)
Military Engineer Services, Engineer-in-Chief's Branch,Integrated HQ of Ministry of Defence, New Delhi	Brig Girish Joshi Lt Col Gaurav Kaushik (*Alternate*)
National Council for Cement and Building Materials, Ballabgarh	Dr Shri Harsh Shri U. S. Sinha (*Alternate*)
Ready Mixed Concrete Manufacturers' Association, Mumbai	Shri Vijay kumar R. Kulkarni Shri S. D. Govilkar (*Alternate*)

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act*, 2016 to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

Review of Indian Standards

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 (10874).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones: 2323 0131, 2323 3375, 2323 9402 *Website*: www.bis.gov.in

Regional Offices:		*Telephones*
Central	: Manak Bhavan, 9 Bahadur Shah Zafar Marg, NEW DELHI 110002	2323 7617, 2323 3841
Eastern	: 1/14 C.I.T. Scheme VII M, V.I.P. Road, Kankurgachi, KOLKATA 700054	2337 8499, 2337 8561, 2337 8626, 2337 9120
Northern	: Plot No. 4-A, Sector 27-B, Madhya Marg, CHANDIGARH 160019	265 0206, 265 0290
Southern	: C.I.T. Campus, IV Cross Road, CHENNAI 600113	2254 1216, 2254 1442, 2254 2519, 2254 2315
Western	: Manakalaya, E9 MIDC, Marol, Andheri (East), MUMBAI 400093	2832 9295, 2832 7858, 2832 7891, 2832 7892

Branches : AHMEDABAD. BENGALURU. BHOPAL. BHUBANESHWAR. COIMBATORE. DEHRADUN. DURGAPUR. FARIDABAD. GHAZIABAD. GUWAHATI. HYDERABAD. JAIPUR. JAMMU. JAMSHEDPUR. KOCHI. LUCKNOW. NAGPUR. PARWANOO. PATNA. PUNE. RAIPUR. RAJKOT. VISAKHAPATNAM.

Published by BIS, New Delhi