भारतीय मानक
Indian Standard

IS 1489 (Part 2) : 2015
(Reaffirmed 2020)

पोर्टलैंड पोजोलाना सीमेंट — विशिष्टि

भाग 2 निस्तापित मिट्टी आधारित

(चौथा पुनरीक्षण)

Portland Pozzolana Cement — Specification

Part 2 Calcined Clay Based

(Fourth Revision)

ICS 91.100.10

भारतीय मानक ब्यूरो
BUREAU OF INDIAN STANDARDS
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October 2015 **Price Group 5**

Cement and Concrete Sectional Committee, CED 2

FOREWORD

This Indian Standard (Part 2) (Fourth Revision) 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.

This standard was first published in 1962 and subsequently revised in 1967 and 1976. The standard was thereafter revised in 1991 where it was split into two parts based on the pozzolana used in the manufacture of such cements. This standard (Part 2) covers pozzolana cement manufactured by using either calcined clay or a mixture of calcined clay and fly ash as pozzolana, and Part 1 covers pozzolana cement manufactured by using only fly ash pozzolana. This fourth revision incorporates the experience gained with the use of this specification and brings the standard in line with the latest developments in this field.

This standard pertains to calcined clay based Portland pozzolana cement and covers the requirements such as its manufacture, chemical and physical requirements, packing and marking.

Since the last revision of this standard, a number of amendments were issued from time to time in order to modify various requirements based on experience gained with the use of the standard and the requirements of the users. These amendments have been incorporated in this revision so as to make it more convenient for the users. Further, following are the significant modifications incorporated in this revision:

a) Reference to relevant Indian Standard has been given for the quality of clinker to be used for manufacture of Portland pozzolana cement.
b) SO_3 content requirement has been revised to 3.5 percent maximum, based on the studies in regard to the same, and also considering the use of coal/pet coke as fuel which may have higher sulphur content; subject to the cement conforming to all the requirements of the standard.
c) Minimum limit of insoluble residue has been included.
d) A clause has been introduced requiring manufacturer to furnish a certificate indicating alkali content, if required by the purchaser.
e) Requirement of testing the cement samples at the earliest but not later than 3 months since the receipt of samples for testing, has been included.
f) Requirement of marking the 'best before date' of cement has been introduced.

With the increase in SO_3 content limit in this revision, suitable caution needs to be exercised for limiting the sulphates in concrete in accordance with the provision of IS 456 : 2000 'Code of practice for plain and reinforced concrete (*fourth revision*)'.

Quantity of cement packed in bags and the tolerance requirements for the quantity of cement packed in bags shall be in accordance with the relevant provisions of the *Standards of Weights and Measures (Packaged Commodities) Rules*, 2011 and **B-1.2**. Any modification in these rules in respect of tolerance on quantity of cement would apply automatically to this standard.

This standard contains Table 2, Sl No. (vi) and **13.2.1** which give option to the purchaser and Table 3, Sl No. (v) and **10.2, 10.3, 10.4** and **10.4.3,** 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 C.

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

PORTLAND POZZOLANA CEMENT — SPECIFICATION

PART 2 CALCINED CLAY BASED

(Fourth Revision)

1 SCOPE

This standard (Part 2) covers the manufacture and chemical and physical requirements of Portland pozzolana cement using calcined clay pozzolana or a mixture of calcined clay and fly ash pozzolana.

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

3.1 Portland Pozzolana Cement — An intimately interground mixture of Portland cement clinker/ ordinary Portland cement and pozzolana with the possible addition of gypsum (natural or chemical) or an intimate and uniform blending ordinary Portland cement and fine pozzolana with addition of ground gypsum, if required.

4 RAW MATERIAL

4.1 Pozzolana

Pozzolana used in the manufacture of calcined clay based Portland pozzolana cement shall be either calcined clay pozzolana conforming to IS 1344 or a mixture of calcined clay pozzolana conforming to IS 1344 and fly ash conforming to IS 3812 (Part 1).

4.2 Portland Cement Clinker

The Portland cement clinker used in the manufacture of Portland-pozzolana cement shall conform to IS 16353.

4.3 Ordinary Portland Cement

Ordinary Portland cement for blending for manufacture of cement as per this standard shall conform to IS 269.

5 MANUFACTURE

Portland Pozzolana cement shall be manufactured either by,

a) intimately inter-grinding Portland cement clinker and calcined clay pozzolana or a mixture of calcined clay pozzolana and fly ash; or

b) intimately and uniformly blending ordinary Portland cement and finely ground calcined clay pozzolana or a mixture of finely ground calcined clay pozzolana and fine fly ash;

with required addition of gypsum so as to produce a cement capable of complying with this standard. The total pozzolana constituent shall not be less than 10 percent and not more than 25 percent by mass of Portland pozzolana cement. The homogeneity of the mixture shall be guaranteed within ±3 percent of the declared pozzolana addition, in the same consignment.

When Portland pozzolana cement is obtained by grinding calcined clay or a mixture of calcined clay and fly ash with Portland cement clinker, no material shall be added after burning, other than gypsum [natural mineral or chemical (*see* Note)], water, and not more than a total of 1.0 percent of air-entraining agents or other agents including colouring agents, which have proved not to be harmful. The limitation of all such additions shall also apply to manufacture of Portland pozzolana cement by blending process.

NOTE — Chemical gypsum shall be added provided that the performance requirements of the final product as specified in this standard are met with.

6 CHEMICAL REQUIREMENTS

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

7 PHYSICAL REQUIREMENTS

Portland pozzolana cement shall comply with the physical requirements given in Table 2.

Table 1 Chemical Requirements for Portland Pozzolana Cement

(*Clause* 6.1)

Sl No.	Characteristic	Requirement
(1)	(2)	(3)
i)	Insoluble residue, percent by mass:	
	a) *Max*	$x + \frac{4.0(100-x)}{100}$
	b) *Min*	0.6 x
		Where x is the declared percentage of pozzolana in the given Portland pozzolana cement.
ii)	Magnesia, percent by mass, *Max*	6.0
iii)	Total sulphur content calculated as sulphuric anhydride (SO_3), percent by mass, *Max*	3.5
iv)	Loss on ignition, percent by mass, *Max*	5.0
v)	Chloride content, percent by mass, *Max*	0.1 0.05 (for prestressed structures)
vi)	Alkali content (*see* Note)	*See* Note 1

NOTE — 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 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.

8 STORAGE

The 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 cement from dampness and to minimize warehouse deterioration (*see also* IS 4082).

9 MANUFACTURER'S CERTIFICATE

9.1 The manufacturer shall satisfy himself that the 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 cement (except for 28 days compressive strength test results, which shall be furnished after completion of the test).

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

10 PACKING

10.1 The cement 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) Light weight jute conforming to IS 12154,
d) HDPE/ PP woven sacks conforming to IS 11652,
e) Jute synthetic union bags conforming to IS 12174, or
f) Any other approved composite bag.

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

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

10.2 The net quantity of 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 **10.1**. The quantity of cement in the bags shall also be subject to tolerances as given in Annex B for 50 kg bags.

10.3 Supplies of 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 quantity of cement, shall be considered as the bulk supply of cement. Supplies of cement may also be made in intermediate bags/containers, for example, drums of 200 kg, by agreement between the purchaser and the manufacturer.

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

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

10.4.2 The words 'FOR EXPORT' and the net quantity of cement per bag/drum shall be clearly marked in indelible ink on each bag/drum.

10.4.3 The packing material shall be as agreed to between the manufacturer and the purchaser.

10.4.4 The tolerance requirements for the quantity of cement packed in bags/drum shall be as given in **10.2.1** except the net quantity which shall be equal to or more than the quantity in **10.4**.

Table 2 Physical Requirements for Portland Pozzolana Cement

(*Clause* 7)

Sl No.	Characteristic	Requirement	Method of Test, Ref to
(1)	(2)	(3)	(4)
i)	Fineness, m^2/kg, *Min*	300	IS 4031 (Part 2)
ii)	Soundness:		
	a) By Le-Chatelier method, mm, *Max*	10 *see* Note 1	IS 4031 (Part 3)
	b) By autoclave test method, percent, *Max*	0.8	
iii)	Setting time:		
	a) Initial, min, *Min*	30 *see* Note 2	IS 4031 (Part 5)
	b) Final, min, *Max*	600	
iv)	Compressive strength, MPa (*see* Note 3):		
	a) 72 ± 1 h, *Min*	16	IS 4031 (Part 6)
	b) 168 ± 2 h, *Min*	22	
	c) 672 ± 4 h, *Min*	33	
v)	Transverse strength (optional)	*See* Notes 3 and 4	IS 4031 (Part 8)
vi)	Drying shrinkage, percent, *Max*	0.15	IS 4031 (Part 10)

NOTES

1 In the event of cements failing to comply with any one or both the requirements of soundness specified in the above table, further tests in respect of each failure shall be made as described in IS 4031 (Part 3), from another portion of the same sample after aeration. The aeration shall be done by spreading out the sample to a depth of 75 mm at a relative humidity of 50 to 80 percent for a total period of 7 days. The expansion of cements so aerated shall be not more than 5 mm and 0.6 percent when tested by Le-Chatelier method and autoclave test, respectively.

2 If cement exhibits false set, the ratio of final penetration measured after 5 min of completion of mixing period to the initial penetration measured exactly after 20 s of completion of mixing period, expressed as percent, shall be not less than 50. In the event of cement exhibiting false set, the initial and final setting time of cement when tested by the method described in IS 4031 (Part 5) after breaking the false set, shall conform to the value given in the above table.

3 Notwithstanding the compressive and transverse strength requirements specified as per the above table, the cement shall show a progressive increase in strength from the strength at 72 h.

4 By agreement between the purchaser and the manufacturer, transverse strength test of plastic mortar in accordance with the method described in IS 4031 (Part 8) may be specified. The permissible values of the transverse strength shall be mutually agreed to between the purchaser and the supplier at the time of placing the order.

11 MARKING

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

a) Manufacturer's name and his registered trade-mark, if any;
b) The words 'Portland pozzolana cement: Calcined clay based';
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) Best before date (that is, 3 months from date of packing);
g) The need for testing of cement more than 3 months old to check conformity before its use;
h) Address of the manufacturer; and
j) Percentage of pozzolana addition (to be given individually for the pozzolanas added).

11.2 Similar information shall be provided in the delivery advices accompanying the shipment of packed or bulk cement and on cement drums (*see* **10.3**).

11.3 BIS Certification Marking

The cement may also be marked with the Standard Mark.

11.3.1 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.

12 SAMPLING

12.1 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 cement is required or by the latter's representative.

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

12.1.2 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.

12.2 In addition to the requirements of **12.1**, the methods and procedure of sampling shall be in accordance with IS 3535.

12.3 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 cement and for subsequent identification of cement sampled.

13 TESTS

13.1 The sample or samples of cement for test shall be taken as described in **12** and shall be tested in the manner described in the relevant clauses.

13.2 Independent Testing

13.2.1 If the purchaser or his representative requires independent tests, the samples shall be taken before or immediately after delivery at 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.

13.2.2 The manufacturer/supplier shall supply, free of charge, the 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/supplier, if the results show that the cement does not comply with the requirements of this standard, and

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

13.2.3 After a representative sample has been drawn, tests on the sample shall be carried out as expeditiously as possible (*see* **12.1.1** and **12.1.2**).

14 REJECTION

14.1 Cement may be rejected, if it does not comply with any of the requirements of this specification.

14.2 Cement remaining in bulk storage at the factory, prior to shipment, for more than six months, or cement in bags, in local storage such as, in the hands of a vendor for more than 3 months after completion of tests, shall be retested before use and shall 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	Specification for ordinary Portland cement (*sixth revision*)
1344 : 1981	Specification for calcined clay pozzolana (*second revision*)
1760 (Part 3) : 1992	Methods of chemical analysis of limestone, dolomite and allied materials: Part 3 Determination of iron oxide, alumina, calcium oxide and magnesia (*first revision*)
2580 : 1995	Textiles — Jute sacking bags for packing cement — Specification (*third revision*)
3535 : 1986	Methods of sampling hydraulic cements (*first revision*)
3812 (Part 1) : 2013	Specification for pulverized fuel ash: Part 1 For use as pozzolana in cement, cement mortar and concrete (*third revision*)
4031	Methods of physical tests for hydraulic cement
(Part 2) : 1999	Determination of fineness by specific surface by Blaine air permeability method (*second revision*)
(Part 3) : 1988	Determination of soundness (*first revision*)
(Part 5) : 1988	Determination of initial and final setting times (*first revision*)
(Part 6) : 1988	Determination of compressive strength of hydraulic cement (other than masonry cement) (*first revision*)
(Part 8) : 1988	Determination of transverse and compressive strength of plastic mortar using prism (*first revision*)
(Part 10) : 1988	Determination of drying shrinkage (*first revision*)
4032 : 1985	Methods of chemical analysis of

IS No.	*Title*
	hydraulic cement (*first revision*)
4082 : 1996	Recommendations on stacking and storage of construction materials and components at site (*second revision*)
4845 : 1968	Definitions and terminology relating to hydraulic cement
4905 : 1968	Methods for random sampling
11652 : 2000	Specification for high density polyethylene (HDPE)/polypropylene (PP) woven sacks for packing cement (*second revision*)
11761 : 1997	Specification for multi-wall paper sacks for cement (*first revision*)
12089 : 1987	Specification for granulated slag for manufacture of Portland slag cement
12154 : 1987	Light weight jute bags for packing cement
12174 : 1987	Jute synthetic union bags for packing cement
16353 : 2015	Specification for Portland cement clinker

ANNEX B

(*Foreword and Clause* 10.1.1)

TOLERANCE REQUIREMENTS FOR THE QUANTITY OF CEMENT PACKED IN BAGS

B-1 The average of the net quantity of 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.

B-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 cement in the bag.

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

NOTE — The mass of a jute sacking bag to hold 50 kg of cement is 531 g, the mass of a 6-ply paper bag to hold 50 kg of cement is approximately 400 g, the mass of a light weight jute bag to hold 50 kg of cement is approximately 450 g, the mass of a HDPE/PP woven sack to hold 50 kg of cement is approximately 70 g/71 g respectively, and the mass of a jute synthetic union bag to hold 50 kg of cement is approximately 420 g.

ANNEX C

(*Foreword*)

COMMITTEE COMPOSITION

Cement and Concrete Sectional Committee, CED 2

Organization	*Representative(s)*
Delhi Tourism and Transportation Development Corporation Ltd, New Delhi	Shri Jose Kurian (*Chairman*)
ACC Ltd, Mumbai	Shri S. A. Khadilkar Shri Raman Sadanand Parulekar (*Alternate*)
Ambuja Cements Limited, Mumbai	Shri J. P. Desai Shri C. M. Dordi (*Alternate*)
Atomic Energy Regulatory Board, Mumbai	Shri L. R. Bishnoi Shri Saurav Acharya (*Alternate*)
Builders' Association of India, Mumbai	Representative
Building Materials and Technology Promotion Council, New Delhi	Shri J. K. Prasad Shri C. N. Jha (*Alternate*)
Cement Manufacturers' Association, Noida	Dr K. C. Narang Dr S. K. Handoo (*Alternate*)
CSIR-Central Building Research Institute, Roorkee	Shri S. K. Singh Shri Subhash Gurram (*Alternate*)
CSIR-Central Road Research Institute, New Delhi	Dr Rakesh Kumar
CSIR-Structural Engineering Research Centre, Chennai	Dr K. Ramanjaneyulu Shri P. Srinivasan (*Alternate*)
Central Public Works Department, New Delhi	Shri A. K. Garg
Central Soil and Materials Research Station, New Delhi	Shri Murari Ratnam Shri S. L. Gupta (*Alternate*)
Central Water Commission, New Delhi	Director (CMDD) (N&W) Deputy Director (CMDD) (NW&S) (*Alternate*)
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Delhi Development Authority, New Delhi	Chief Engineer (Design) Executive Engineer (Design) (*Alternate*)
Engineers India Limited, New Delhi	Shri Rajanji Srivastava Shri Anurag Sinha (*Alternate*)
Fly Ash Unit, Deptt of Science and Technology, New Delhi	Shri Chander Mohan
Gammon India Limited, Mumbai	Shri Venkataramana N. Heggade Shri Manish Mokal (*Alternate*)
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Housing and Urban Development Corporation Limited, New Delhi	Shri Deepak Bansal
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Indian Institute of Technology Madras, Chennai	Dr Devdas Menon Dr Manu Santhanam (*Alternate*)
Indian Institute of Technology Roorkee, Roorkee	Dr V. K. Gupta Dr Bhupinder Singh (*Alternate*)
Indian Roads Congress, New Delhi	Secretary General Director (*Alternate*)

Organization	*Representative(s)*
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Public Works Department, Govt of Tamil Nadu, Chennai	Superintending Engineer Executive Engineer (*Alternate*)
The India Cements Limited, Chennai	Dr D. Venkateswaran Shri S. Gopinath (*Alternate*)
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 National Institute of Engineering, Mysore	Dr N. Suresh Shri H. N. Ramathirtha (*Alternate*)
The Ramco Cements Ltd, Chennai	Shri Balaji K. Moorthy Shri Anil Kumar Pillai (*Alternate*)
Ultra Tech Cement Ltd, Mumbai	Dr Subrato Chowdhury Shri Biswajit Dhar (*Alternate*)
Voluntary Organization in Interest of Consumer Education, New Delhi	Shri M. A. U. Khan Shri H. Wadhwa (*Alternate*)
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BIS Directorate General	Shri B. K. Sinha Scientist 'E' and Head (Civ Engg) [Representing Director General (*Ex-officio*)]

Member Secretaries
Shri Sanjay Pant
Scientist 'E' (Civ Engg), BIS
and
Shri S. Arun Kumar
Scientist 'C' (Civ Engg), BIS

Cement, Pozzolana and Cement Additives Sub-committee, CED 2:1

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ACC Ltd, Mumbai	Shri S. A. Khadilkar Shri Raman Sadanand Parulekar (*Alternate*)

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CSIR-Central Road Research Institute, New Delhi	Shri J. B. Sengupta
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Central Public Works Department, New Delhi	Shri A. K. Garg Shri Rajesh Khare (*Alternate*)
Central Soil and Materials Research Station, New Delhi	Shri Murari Ratnam Shri N. Siva Kumar (*Alternate*)
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Gammon India Limited, Mumbai	Shri Avinash Y. Mahendrakar Shri Manish Mokal (*Alternate*)
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Military Engineer Services, Engineer-in-Chief Branch, Army HQ, New Delhi	Brig. S. B. Vajramatti Shri Subodh Kumar (*Alternate*)
Ministry of Commerce & Industry (DIPP), New Delhi	Industrial Adviser Senior Development Officer (*Alternate*)
National Council of Cement and Building Materials, Ballabgarh	Dr M. M. Ali Dr S. Harsh (*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	Shri Masoom Ali
OCL India Limited, New Delhi	Dr S. C. Ahluwalia
Public Works Department, Govt of Tamil Nadu, Chennai	Joint Chief Engineer (Irrigation) Executive Engineer (*Alternate*)

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Tata Steel Ltd, Jamshedpur	Shri A. S. Reddy Shri Vipul Mohan Korrane (*Alternative*)
The Ramco Cements Ltd, Chennai	Shri Balaji K. Moorthy Shri Anil Kumar Pillai (*Alternate*)
Ultra Tech Cement Ltd, Mumbai	Shri Subrato Chowdhury Shri M. R. Kalgal (*Alternate*)
In personal capacity (*Type IV/17, President's Estate, New Delhi)*	Shri K. H. Babu

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

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