Indian Standard

ORDINARY PORTLAND CEMENT, 53 GRADE — SPECIFICATION

(First Revision)

ICS 91.100.10
FOREWORD

This Indian Standard (First 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 published in 1987. This revision incorporates the experience gained with the use of this standard and brings the standard in line with the latest developments in this field.

Since the publication of this standard, a large 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, and also keeping in view the raw materials available in the country and found suitable for the manufacture of cement. The important amendments included: use of performance improvers for addition during clinker grinding stage, incorporation of requirement of chloride content for the cement used in structures other than prestressed concrete, permitting use of 25 kg, 10 kg, 5 kg, 2 kg and 1 kg bags for packing of cement, and requirement of packing cement for export. In view of the large number of amendments, the Sectional Committee decided to bring out this first revision of the standard incorporating all these amendments so as to make it more convenient for the users. Further, following are the other significant modifications incorporated in this revision:

a) Requirement for insoluble residue has been specified as 5.0 percent, maximum irrespective of addition of performance improver(s) or otherwise.

b) $SO_3$ content requirement has been revised to 3.5 percent maximum irrespective of $C_A$ content, primarily to accommodate 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) A clause has been introduced requiring manufacturer to furnish a certificate indicating alkali content if required by the purchaser.

d) Requirement of marking of type and amount of performance improver(s) on the bag has been incorporated.

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.

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, 1977 and B-1.2 (see Annex B). Any modification in these rules in respect of tolerance on quantity of cement would apply automatically to this standard.

This standard contains Sl No. (viii) of Table 2 and 12.2.1 which give option to the purchaser and Sl No. (v) of Table 3 and 9.2, 9.3, 9.4 and 9.4.3, which call for agreement between the purchaser and the supplier.

Specific requirements of ordinary Portland cement for manufacture of railway sleepers to be designated as 53-S grade are given in 5.2, Table 3 and 10.1. To differentiate it with normal grade, ‘53-S grade’ shall be marked on the bags/packages for such cement in place of ‘53 grade’.

The composition of the technical 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
ORDINARY PORTLAND CEMENT,
53 GRADE — SPECIFICATION
( First Revision )

1 SCOPE
This standard covers the manufacture and chemical and physical requirements of 53 grade ordinary Portland cement.

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 definitions given in IS 4845 shall apply.

4 MANUFACTURE
4.1 Ordinary Portland cement, 53 grade shall be manufactured by intimately mixing together calcareous and argillaceous and/or other silica, alumina or iron oxide bearing materials, burning them at a clinkering temperature and grinding the resultant clinker so as to produce a cement capable of complying with this standard. No material shall be added after burning, other than gypsum (natural mineral or chemical, see Note), water, performance improver(s), 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.

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

4.1.1 Limit of addition of performance improver shall be as given in Table 1 and shall be inclusive of 1 percent additives as mentioned above.

If a combination of above performance improvers is added, the maximum limit of total addition shall be 5 percent.

5 CHEMICAL REQUIREMENTS
5.1 When tested in accordance with the methods given in IS 4032, ordinary Portland cement, 53 grade shall comply with the chemical requirements given in Table 2.

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>Performance Improver</th>
<th>Percentage Addition by Mass, Max</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fly ash</td>
<td>5</td>
<td>Conforming to IS 3812 (Part 1)</td>
</tr>
<tr>
<td>2</td>
<td>Granulated slag</td>
<td>5</td>
<td>Conforming to IS 12089</td>
</tr>
<tr>
<td>3</td>
<td>Silica fume</td>
<td>5</td>
<td>Conforming to IS 15388</td>
</tr>
<tr>
<td>4</td>
<td>Limestone</td>
<td>5</td>
<td>CaCO&lt;sub&gt;3&lt;/sub&gt; content calculated from CaO content shall not be less than 75 percent when tested in accordance with IS 1760 (Part 3)</td>
</tr>
<tr>
<td>5</td>
<td>Rice husk ash</td>
<td>5</td>
<td>a) Reactive silica shall not be less than 80 percent when tested as per IS 3812 (Part 1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b) Pozzolanic activity index shall not be less than 90 percent when tested as per 10 of IS 1727</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>c) Loss on ignition shall not be more than 5.0 percent when tested as per IS 1727</td>
</tr>
<tr>
<td>6</td>
<td>Metakaolin</td>
<td>5</td>
<td>a) Silicon dioxide (SiO&lt;sub&gt;2&lt;/sub&gt;) plus aluminium oxide (Al&lt;sub&gt;2&lt;/sub&gt;O&lt;sub&gt;3&lt;/sub&gt;) in percent by mass shall not be less than 94.0 percent when tested as per IS 1727</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b) Loss on ignition shall not be more than 2.0 percent when tested as per IS 1727</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>c) Total alkalis as sodium oxide (as Na&lt;sub&gt;2&lt;/sub&gt;O equivalent) in percent by mass shall not be more than 1.5 percent when tested as per IS 4032</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>d) Particles retained on 45 micron IS sieve (wet sieving) shall not be more than 1.5 percent when tested as per IS 1727</td>
</tr>
</tbody>
</table>
Table 2 Chemical Requirements for Ordinary Portland Cement, 53 Grade

(Forword and Clauses 5.1 and 5.2)

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>Characteristic</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>i)</td>
<td>Ratio of percentage of lime to percentages of silica, alumina and iron oxide, when calculated by the formula:</td>
<td>0.80-1.02</td>
</tr>
</tbody>
</table>
|       | \[
|       | \frac{\text{CaO}}{0.7 \text{SO}_3} + \frac{2.8 \text{SiO}_2 + 1.2 \text{Al}_2\text{O}_3 + 0.65 \text{Fe}_2\text{O}_3}{\text{Fe}_2\text{O}_3} \] |
| ii)   | Ratio of percentage of alumina to that of iron oxide, Min | 0.66             |
| iii)  | Insoluble residue, percent by mass, Max      | 4.0              |
| iv)   | Magnesia, percent by mass, Max               | 6.0              |
| v)    | Total sulphur content calculated at sulphuric anhydride (SO₃), 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                               | 0.05 (for prestressed structures, see Note) |

NOTE — Alkali aggregates reactions have been noticed in aggregates in some parts of the country. 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 at sodium oxide (Na₂O), 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 8.2.5.4 of IS 456. If so desired by the purchaser, the manufacturer shall carry out test for alkali content.

5.2 Cement used for railway sleepers shall additionally satisfy the following chemical/mineralogical requirements and shall be designated as 53-S grade:

a) Magnesia, percent by mass, Max 5.0
b) Tricalcium aluminate content, percent by mass, Max 10.0
c) Tricalcium silicate, percent by mass, Min 45.0

NOTE — The tricalcium aluminate content (C₃A) and tricalcium silicate content (C₃S) are calculated by the formula:

\[
\begin{align*}
C_3A &= 2.65 (\text{Al}_2\text{O}_3) - 1.69 (\text{Fe}_2\text{O}_3) \\
C_3S &= 4.07 (\text{CaO}) - 7.60 (\text{SiO}_2) - 6.72 (\text{Al}_2\text{O}_3) - 1.43 (\text{Fe}_2\text{O}_3) - 2.85 (\text{SO}_3)
\end{align*}
\]

where each symbol in brackets refers to the percent (by mass of total cement) of the oxide, excluding any contained in insoluble residue referred to at Sl No. (iii) of Table 2.

6 PHYSICAL REQUIREMENTS

Ordinary Portland cement, 53 grade shall comply with the physical requirements given in Table 3.

7 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).

8 MANUFACTURER’S CERTIFICATE

8.1 The manufacturer shall satisfy himself that the cement conforms to the requirements of this standard and, if requested, shall furnish a 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).

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

9 PACKING

9.1 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.

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

9.2 The net quantity of cement per bag may also be 25 kg, 10 kg, 5 kg, 2 kg or 1 kg subject to tolerances as given in 9.2.1 and packed in suitable bags as agreed to between the purchaser and the manufacturer.

9.2.1 The number of bags in a sample taken for
### Table 3 Physical Requirements for Ordinary Portland Cement, 53 Grade
*(Foreword and Clause 6)*

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>Characteristic</th>
<th>Requirement</th>
<th>Method of Test, Ref to</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
</tr>
<tr>
<td>i)</td>
<td>Fineness, m²/kg, Min</td>
<td>225</td>
<td>IS 4031 (Part 2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>370 for 53-S grade</td>
<td></td>
</tr>
<tr>
<td>ii)</td>
<td>Soundness:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a) By Le Chatelier method, mm, Max</td>
<td>10</td>
<td>IS 4031 (Part 3)</td>
</tr>
<tr>
<td></td>
<td>b) By autoclave test method, percent, Max</td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td>iii)</td>
<td>Setting time:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a) Initial, min, Min</td>
<td>30</td>
<td>IS 4031 (Part 5)</td>
</tr>
<tr>
<td></td>
<td>b) Final, min, Max</td>
<td>600</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>60 for 53-S grade</td>
<td></td>
</tr>
<tr>
<td>iv)</td>
<td>Compressive strength, MPa <em>(see Note 4)</em>:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a) 72 ± 1 h, Min</td>
<td>27</td>
<td>IS 4031 (Part 6)</td>
</tr>
<tr>
<td></td>
<td>b) 168 ± 2 h, Min</td>
<td>37</td>
<td></td>
</tr>
<tr>
<td></td>
<td>c) 672 ± 4 h, Min</td>
<td>37.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>53</td>
<td></td>
</tr>
<tr>
<td>v)</td>
<td>Transverse strength (optional)</td>
<td>See Notes 3 and 4</td>
<td>IS 4031 (Part 8)</td>
</tr>
</tbody>
</table>

**NOTES**

1. In the event of cements failing to comply with any one or both the requirements of soundness specified in this 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 not be more than 5 mm and 0.6 percent when tested by Le Chatelier method and autoclave test respectively. For 53-S grade cement, the requirement of soundness of unaerated cement shall be maximum expansion of 5 mm when tested by the Le-Chatelier method.

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 this table.

3. 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.

4. Notwithstanding the compressive and transverse strength requirements specified as per this table, the cement shall show a progressive increase in strength from the strength at 72 h.
c) Net quantity, in kg;
d) The words ‘Use no Hooks’;
e) Batch/control unit number in terms of week, month and year of packing;
f) Address of the manufacturer; and
g) Type and percentage of performance improver(s) added, in case of addition of performance improvers.

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

10.3 BIS Certification Marking
The 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, 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.

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 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 cement and for subsequent identification of cement sampled.

12 TESTS
12.1 The sample or samples of 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 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.

12.2.2 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.

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

13.2 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 standard.
ANNEX A
(Clauses 2)
LIST OF REFERRED INDIAN STANDARDS

<table>
<thead>
<tr>
<th>IS No.</th>
<th>Title</th>
<th>IS No.</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>1727 : 1967</td>
<td>Methods of test for pozzolanic materials (first revision)</td>
<td>1760 (Part 3) : 1992</td>
<td>Methods of chemical analysis of hydraulic cement (first revision)</td>
</tr>
<tr>
<td>1760 (Part 3) : 1992</td>
<td>Methods of chemical analysis of limestone, dolomite and allied materials: Part 3 Determination of iron oxide, alumina, calcium oxide and magnesia (first revision)</td>
<td>4032 : 1985</td>
<td>Recommendations on stacking and storage of construction materials and components at site (second revision)</td>
</tr>
<tr>
<td>3555 : 1986</td>
<td>Methods of sampling hydraulic cements (first revision)</td>
<td>4845 : 1968</td>
<td>Methods for random sampling</td>
</tr>
<tr>
<td>2013</td>
<td>Part 1 For use as pozzolana in cement, cement mortar and concrete (third revision)</td>
<td>11761 : 1986</td>
<td>Specification for multi-wall paper sacks for cement (first revision)</td>
</tr>
<tr>
<td>4031</td>
<td>Methods of physical tests for hydraulic cement (second revision)</td>
<td>12089 : 1987</td>
<td>Specification for granulated slag for manufacture of Portland slag cement</td>
</tr>
<tr>
<td>(Part 2) : 1999</td>
<td>Determination of fineness by specific surface by Blaine air permeability method (first revision)</td>
<td>12154 : 1987</td>
<td>Light weight jute bags for packing cement</td>
</tr>
<tr>
<td>(Part 5) : 1988</td>
<td>Determination of initial and final setting times (first revision)</td>
<td>15388 : 2003</td>
<td>Specification for silica fume</td>
</tr>
</tbody>
</table>

ANNEX B
(Foreword and Clause 9.1.1)
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:

<table>
<thead>
<tr>
<th>Batch Size</th>
<th>Sample Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>100-150</td>
<td>20</td>
</tr>
<tr>
<td>151-280</td>
<td>32</td>
</tr>
<tr>
<td>281-500</td>
<td>50</td>
</tr>
<tr>
<td>501-1 200</td>
<td>80</td>
</tr>
<tr>
<td>1 201-3 200</td>
<td>125</td>
</tr>
<tr>
<td>3 201 and over</td>
<td>200</td>
</tr>
</tbody>
</table>

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.

NOTE — The matter given in B-1 and B-1.1 are extracts based on the Standards of Weights and Measures (Packaged Commodities) Rules, 1977 to which reference shall be made.
for full details. Any modification made in these Rules and other related Acts and Rules would apply automatically.

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

Delhi Tourism and Transportation Development Corporation Ltd, New Delhi
ACC Ltd, Mumbai
Ambuja Cements Limited, Mumbai
Association of Consulting Civil Engineers (India), Bangalore
Atomic Energy Regulatory Board, Mumbai
Builders’ Association of India, Mumbai
Building Materials and Technology Promotion Council, New Delhi
Cement Corporation of India Limited, New Delhi
Cement Manufacturers’ Association, Noida
Central Board of Irrigation and Power, New Delhi
Central Building Research Institute (CSIR), Roorkee
Central Public Works Department, New Delhi
Central Road Research Institute (CSIR), New Delhi
Central Soil and Materials Research Station, New Delhi
Central Water Commission, New Delhi
Conmat Technolgies Pvt Ltd, Kolkata
Construction Chemicals Manufacturers’ Association, Mumbai
Construction Industry Development Council, New Delhi
Delhi Development Authority, New Delhi
Engineers India Limited, New Delhi

Representative(s)

Shri Jose Kurian (Chairman)
Shri S. A. Khadilkar
Shri Sharad Kumar Shrivastava (Alternate)
Shri C. M. Dordi
Dr A. N. Vyasra Rao (Alternate)
Shri Avinashi D. Shibode
Shri K. K. Meghashyam (Alternate)
Shri L. R. Bishnodi
Shri Saurav Acharya (Alternate)
Dr Narendra D. Patel
Shri J. K. Prasad
Shri C. N. Jha (Alternate)
Shri R. R. Deshpande
Shri M. K. Agarwal (Alternate)
Shri N. A. Viswanathan
Dr S. K. Handoo (Alternate)
Secretary
Director (Civil) (Alternate)
Dr B. K. Rao
Dr S. K. Agarwal (Alternate)
Shri A. K. Garj
Shri Manu Amitabh (Alternate)
Dr Rakesh Kumar
Dr Renu Mathur (Alternate)
Shri Mukari Ratnam
Shri N. Sivakumar (Alternate)
Director (CMDD)(N&W)
Deputy Director (CMDD) (NW&S) (Alternate)
Dr A. K. Chatterjee
Shri Samir Surlaker
Shri Upam Patel (Alternate)
Shri P. R. Swarup
Shri Ravi Jain (Alternate)
Chief Engineer (QAC)
Director (Material Management) (Alternate)
Shri Vinay Kumar
Shri A. K. Mishra (Alternate)
Organization

Fly Ash Unit, Department of Science and Technology, New Delhi

Gammon India Limited, Mumbai

Grasim Industries Limited, Mumbai

Hindustan Construction Company Ltd, Mumbai

Housing and Urban Development Corporation Limited, New Delhi

Indian Association of Structural Engineers, New Delhi

Indian Bureau of Mines, Nagpur

Indian Concrete Institute, Chennai

Indian Institute of Technology Kanpur, Kanpur

Indian Institute of Technology Madras, Chennai

Indian Institute of Technology Roorkee, Roorkee

Indian Roads Congress, New Delhi

Institute for Solid Waste Research & Ecological Balance, Visakhapatnam

Jai Prakash Associates Ltd, New Delhi

Lafarge India Pvt Ltd, Mumbai

Madras Cements Ltd, Chennai

Military Engineer Services, Engineer-in-Chief’s Branch, Army Headquarter, New Delhi

Ministry of Road Transport & Highways, New Delhi

National Council for Cement and Building Materials, Ballabgarh

National Test House, Kolkata

Nuclear Power Corporation of India Ltd, Mumbai

OCL India Limited, New Delhi

Public Works Department, Government of Tamil Nadu, Chennai

Research, Design & Standards Organization (Ministry of Railways), Lucknow

Sanghi Industries Limited, Sanghi Nagar

Structural Engineering Research Centre (CSIR), Chennai

The India Cements Limited, Chennai

The Indian Hume Pipe Company Limited, Mumbai

Representative(s)

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Shri Venkataramana N. Hegde
Shri Manish Mochal (Alternate)

Shri A. K. Jain
Dr. S. P. Pandey (Alternate)

Dr. Chetan Hazaree
Shri Manohar Cherala (Alternate)

Shri Deepak Bansal

Prof. Mareshe Tandon
Shri Ganesh Juneja (Alternate)

Shri S. S. Das
Shri Meenul Hasan (Alternate)

Shri Vivek Naik
Secretary General (Alternate)

Dr. Sudhir Misra
Dr. Sudib K. Mishra (Alternate)

Prof. Devdas Menon
Dr. Manu Sankhyanam (Alternate)

Prof. V. K. Gupta
Dr. Bhupinder Singh (Alternate)

Secretary General
Director (Alternate)

Dr. N. Bhanumathidas
Shri N. Kalidas (Alternate)

Shri M. K. Ghosh
Ms. Madhumita Basu
Shri Sanjay Jain (Alternate)

Shri Balaji K. Moodi
Shri Anil Kumar Pillai (Alternate)

Maj-Gen N. R. K. Babu
Shri S. K. Jain (Alternate)

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Shri S. K. Purie (Alternate)

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## IS 12269 : 2013

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<td>Dr. N. Suresh</td>
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