Indian Standard

43 GRADE ORDINARY PORTLAND CEMENT — SPECIFICATION

(First Revision)

भारतीय मानक

43 ग्रेड साधारण पोर्टलैंड सीमेंट — विशिष्टि

(पहला पुनरीक्षण)

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BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

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FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards on 30 October 1989, 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 1976 under the title 'Specification for high strength ordinary Portland cement'. Since publication of this standard, large number of amendments have been 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 and fuel available in the country for manufacture of cement. The important amendments include increasing the value of total loss on ignition from 4 to 5 percent, modifying the requirement of total sulphur content calculated as sulphuric anhydride (SO_3) reducing the fineness by specific surface of cement from 350 m^2/kg to 225 m^2/kg, making autoclave soundness test compulsory irrespective of magnesia content, incorporating a provision for retest in respect of autoclave soundness test after aeration of the cement, incorporating a clause on false set of cement, permitting packaging of cement in 25 kg bags and making compulsory provision for issuing a certificate indicating the total chloride content in cement. Further, in view of the decision to designate ordinary Portland cement by its 28-day compressive strength, the title of this standard was modified as '43 grade ordinary Portland cement — Specification'. In view of these large number of amendments, the Sectional Committee decided to bring out the first revision of the standard incorporating all these amendments, so as to make it more convenient for the users.

This specification intends to cover the requirements of ordinary Portland cement used for the manufacture of prestressed concrete sleepers also. Some requirements of 43 grade ordinary Portland cement for uses, such as, manufacture of railway sleepers and precast products may be agreed to between the purchaser and the supplier.

Mass of cement packed in bags and the tolerance requirements 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 for information). Any modification in these rules in respect of tolerance on mass of cement would apply automatically to this standard.

This standard contains **11.4.1** which permits the purchaser to use his option for testing and **6.1**, **6.5**, **9.2.1** and **9.3** which call for agreement between the purchaser and the manufacturer.

In the formulation of this standard considerable assistance has been rendered by National Council for Cement and Building Materials, New Delhi as many of these modifications are based on studies carried out by them.

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.

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43 GRADE ORDINARY PORTLAND CEMENT — SPECIFICATION

(First Revision)

1 SCOPE

1.1 This standard covers the manufacture, chemical and physical requirements of 43 grade ordinary Portland cement.

2 REFERENCES

2.1 The Indian Standards listed in Annex A are necessary adjuncts to this standard.

3 TERMINOLOGY

3.1 For the purpose of this standard, the definitions given in IS 4845 : 1968 shall apply.

4 MANUFACTURE

4.1 43 grade ordinary Portland cement shall be manufactured by intimately mixing together calcareous and agrillaceous 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 specification. No material shall be added after burning other than gypsum (natural or chemical) or water or both, and not more than one percent of air-entraining agents or other agents, which have proved not to be harmful.

5 CHEMICAL REQUIREMENTS

5.1 When tested in accordance with the methods given in IS 4032 : 1985, 43 grade ordinary Portland cement shall comply with the chemical requirements given in Table 1.

6 PHYSICAL REQUIREMENTS

6.1 Fineness

When tested for fineness by Blaine's air permeability method as described in IS 4031 (Part 2) : 1988, the specific surface of cement shall not be less than 225 m^2/kg.

NOTE — A higher fineness of cement, when specifically required, may be agreed to by mutual agreement between the purchaser and the manufacturer.

Table 1 Chemical Requirements for High Strength Portland Cement
(*Clause* 5.1)

Sl No. (1)	Characteristic (2)	Requirement (3)
i)	Ratio of percentage of lime to percentages of silica, alumina and iron oxide, when calculated by the formula: $\frac{CaO - 0{\cdot}7\,SO_3}{2{\cdot}8\,SiO_2 + 1{\cdot}2Al_2O_3 + 0{\cdot}65\,Fe_2O_3}$	Not greater than 1·02 and not less than 0·66
ii)	Ratio of percentage of alumina to that of iron oxide	Not less than 0·66
iii)	Insoluble residue, percent by mass	Not more than 2
iv)	Magnesia, percent by mass	Not more than 6
v)	Total sulphur content calculated as sulphuric anhydride (SO_3), percent by mass	Not more than 2·5 and 3·0 when tricalcium aluminate (*see* Note 1), percent by mass is 5 or less and greater than 5 respectively
vi)	Total loss on ignition	Not more than 5 percent

NOTES

1 The tricalcium aluminate content (C_3A) is calculated by the formula:

$C_3A = 2{\cdot}65\,(Al_2O_3) - 1{\cdot}69\,(Fe_2O_3)$,

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).

2 Alkali aggregrate 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 as sodium oxide (Na_2O) is recommended.

3 Total chloride content in cement shall not exceed 0·05 percent by mass for cement used in prestressed concrete structures and long span reinforced concrete structures. Method of test for determination of chloride content in cement is given in IS 12423 : 1988.

4 The limit of total chloride content in cement for use in plain and other reinforced concrete structures is being reviewed. Till that time, the limit may be mutually agreed to between the purchaser and the manufacturer.

6.2 Soundness

6.2.1 When tested by the 'Le-Chatelier' method and autoclave test described in IS 4031 (Part 3) : 1988, unaerated cement shall not have an expansion of more than 10 mm and 0·8 percent respectively.

6.2.1.1 In the event of cements failing to comply with any one or both the requirements specified in **6.2.1**, further tests in respect of each failure shall be made as described in IS 4031 (Part 3) : 1988 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.

6.3 Setting Time

The setting time of cement, when tested by the Vicat apparatus method described in IS 4031 (Part 5) : 1988 shall conform to the following requirements:

a) Initial setting time in minutes — not less than 30

b) Final setting time in minutes — not more than 600

6.3.1 If cement exhibits false set, the ratio of final penetration measured after 5 minutes of completion of mixing period to the initial penetration measured exactly after 20 seconds 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) : 1988 after breaking the false set, shall conform to **6.3**.

6.4 Compressive Strength

The average compressive strength of at least three mortar cubes (area of face 50 cm^2) composed of one part of cement, three parts of standard sand (conforming to IS 650 : 1966) by mass and *P*/4 + 3·0 percent (of combined mass of cement plus sand) water, and prepared, stored and tested in the manner described in IS 4031 (Part 6) : 1988, shall be as follows:

a)	72 ±1 hour not less than	23 MPa
b)	168 ±2 hours not less than	33 MPa
c)	672 ±4 hours not less than	43 MPa

NOTE — P is the percentage of water required to produce a paste of standard consistency (*see* **11.3**).

6.5 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) : 1988 may be specified in addition to the test specified in **6.4**. The permissible values of the transverse strength shall be mutually agreed to between the purchaser and the supplier at the time of placing order.

6.6 Notwithstanding the strength requirements specified in **6.4** and **6.5**, cement shall show a progressive increase in strength from the strength at 72 hours.

7 STORAGE

7.1 The cement shall be stored in such a manner as to permit easy access for proper inspection and in a suitable weather-tight building to protect the cement from dampness and to minimize warehouse deterioration.

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 despatch of the cement.

8.2 The manufacturer shall furnish a certificate, within ten days of despatch of cement, indicating the total chloride content in percent by mass of cement.

9 DELIVERY

9.1 The cement shall be packed in bags [jute sacking bag conforming to IS 2580 : 1982, double hessian bituminized (CRI type), multiwall paper conforming to IS 11761 : 1986, polyethylene lined (CRI type) jute, light weight jute conforming to IS 12154 : 1987, woven HDPE conforming to IS 11652 : 1986, woven polypropylene conforming to IS 11653 : 1986, jute synthetic union conforming to IS 12174 : 1987 or any other approved composite bags] bearing the manufacturer's name or his registered trade-mark, if any, and the words '43 Grade Ordinary Portland Cement'. The number of bags (net mass) to the tonne or the average net mass of the cement shall be legibly and indelibly marked on each bag. Bags shall be in good condition at the time of inspection.

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

9.2 The average net mass of cement per bag shall be 50 kg (*see* Annex B).

9.2.1 The average net mass of cement per bag may also be 25 kg subject to tolerances as given in **9.2.1.1** and packed in suitable bags as agreed to between the purchaser and the manufacturer.

9.2.1.1 The number of bags in a sample taken for weighment showing a minus error greater than 2 percent of the specified net mass shall be not more than 5 percent of the bags in the sample. Also the minus error in none of such bags in the sample shall exceed 4 percent of the specified net mass of cement in the bag. However, the average net mass of cement in a sample shall be equal to or more than 25 kg.

9.3 Supplies of cement 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 or more net mass of cement shall be considered as bulk supply of cement. Supplies of cement may also be made in intermediate containers, for example, drums of 200 kg, by agreement between the purchaser and the manufacturer.

10 SAMPLING

10.1 Samples for Testing and by Whom to be Taken

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

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

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

10.2 In addition to the requirements of **10.1**, the methods and procedure of sampling shall be in accordance with IS 3535 : 1986.

10.3 Facilities for Sampling and Identification

The manufacturer or 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 the cement sampled.

11 TESTS

11.1 The sample or samples of cement for test shall be taken as described in **10** and shall be tested in the manner described in the relevant clauses.

11.2 Temperature for Testing

The temperature range within which physical tests may be carried out shall, as far as possible, be $27 \pm 2°C$. The actual temperature during the testing shall be recorded.

11.3 Consistency of Standard Cement Paste

The quantity of water required to produce a paste of standard consistency, to be used for the determination of the water content of mortar for the compressive strength tests and for the determination of soundness and setting time, shall be obtained by the method described in IS 4031 (Part 4) : 1988.

11.4 Independent Testing

11.4.1 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 instruction of the purchaser or his representative.

11.4.2 *Cost of Testing*

The manufacturer 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 if the results show that the cement does not comply with this standard, and

b) by the purchaser if the results show that the cement complies with this standard.

11.4.3 After a representative sample has been drawn, tests on the sample shall be carried out as expeditiously as possible.

12 REJECTION

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

12.2 Cement remaining in bulk storage at the mill, prior to shipment, for more than six months, or 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* 2.1)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*	*IS No.*	*Title*
650 : 1966	Specification for standard sand for testing of cement (*first revision*)	11652 : 1986	Specification for high density polyethylene (HDPE) woven sacks for packing cement
2580 : 1982	Specification for jute sacking bags for packing cement (*second revision*)	11653 : 1986	Specification for polypropylene (PP) woven sacks for packing cement
3535 : 1986	Methods of sampling hydraulic cements (*first revision*)	11761 : 1986	Specification for multi wall paper sacks for cement, valved-sewn-gussetted type
4031 (Parts 1 to 13)	Methods of physical test for hydraulic cement (*first revision*)	12154 : 1987	Specification for light weight jute bags for packing cement
4032 : 1985	Method of Chemical analysis of hydraulic cement (*first revision*)	12174 : 1987	Specification for jute synthetic union bag for packing cement
4845 : 1968	Definitions and terminology relating to hydraulic cement	12423 : 1988	Method for colorimetric analysis of hydraulic cement
4905 : 1968	Methods for random sampling		

ANNEX B

(*Clause* 9.2)

TOLERANCE REQUIREMENTS FOR THE MASS OF CEMENT PACKED IN BAGS

B-1 The average net mass 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 to 150	20
151 to 280	32
281 to 500	50
501 to 1 200	80
1 201 to 3 200	125
3 201 and over	200

The bags in a sample shall be selected at random (*see* IS 4905 : 1968).

B-1.1 The number of bags in a sample showing a minus error greater than 2 percent of the specified net mass (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 the sample shall exceed 4 percent of the specified net mass 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 datails. 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 20 to 25 tonnes, the overall tolerance on net mass of cement shall be 0 to +0·5 percent.

NOTE — The mass of a jute sacking bag conforming to IS 2580 : 1982 to hold 50 kg of cement is 531 g, the mass of a double hessian bituminized (CRI type) bag to hold 50 kg of cement is 630 g, the mass of a 6-ply paper bag to hold 50 kg of cement is approximately 400 g and the mass of a polyethylene lined (CRI type) jute bag to hold 50 kg of cement is approximately 480 g.

ANNEX A

COMPOSITION OF THE TECHNICAL COMMITTEE

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AMENDMENT NO. 1 JANUARY 1991
TO
IS 8112 : 1989 43 GRADE ORDINARY PORTLAND CEMENT — SPECIFICATION

(First Revision)

(*Page* 3, *Clause* **9.2.1.1**) — Insert the following new clauses after **9.2.1.1**:

'**9.2.2** When cement is intended for export and if the purchaser so requires, packing of cement may be done in bags other than those given in **9.2** and **9,2.1** with an average net mass of cement per bag as agreed to between the purchaser and the manufacturer.

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

9.2.2.2 The words 'FOR EXPORT' and the average net mass of cement per bag shall be clearly marked in indelible ink on each bag.

9.2.2.3 The packing material shall be as agreed to between the supplier and the purchaser.

9.2.2.4 The tolerance requirements for the mass of cement packed in bags shall be as given in **9.2.1.1** except the average net mass which shall be equal to or more than the quantity in **9.2.2.**'

(CED 2)

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AMENDMENT NO. 2 NOVEMBER 1991
TO
IS 8112 : 1989 43 GRADE ORDINARY PORTLAND CEMENT — SPECIFICATION

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(*Page* 4, *clause* **B-1.2**) — Substitute 'up to 25 tonnes' *for* 'of 20 to 25 tonnes'.

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(First Revision)

[*Page* 3, *clause* **9.2.1.1** (*see also Amendment No.* 1)] — Substitute the following for the existing matter:

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

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

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

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

9.2.2.4 The tolerance requirements for the mass of cement packed in bags/drum shall be as given in **9.2.1.1** except the average net mass which shall be equal to or more than the quantity in **9.2.2.**'

(CED 2)

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(First Revision)

(*Page* 3, *clause* **9.2.1**) — Substitute the following for the existing clause:

'**9.2.1** The average net mass of cement per bag may also be 25 kg, 10 kg, 5 kg, 2 kg or 1 kg, subject to tolerances as given in **9.2.1.1** and packed in suitable bag as agreed to between the purchaser and the manufacturer.'

(*Page* 3, *clause* **9.2.1.1**) — Substitute the following for the existing clause:

'**9.2.1.1** The number of bags in a sample taken for weighment showing a minus error greater than 2 percent of the specified net mass shall not be more than 5 percent of the bags in the sample. Also the minus error in none of such bags in the sample shall exceed 4 percent of the specified net mass of cement in the bag. However, the average mass of the cement in a sample shall be equal to or more than 25 kg, 10 kg, 5 kg, 2 kg or 1 kg, as the case may be.'

(*Page* 4, *clause* **B-1.2**) — Substitute 'up to 25 tonnes' *for* '20 to 25 tonnes'.

(CED 2)

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(*Page* 1, *clause* **5.1**) — Insert the following after the clause:

'**5.2** Total chloride content in cement shall not exceed 0.1 percent by mass for cement used in structures other than prestressed concrete. For determination of chloride content in cement, IS 12423 may be referred.

NOTE — For use in special structures like prestressed concrete, where chloride is a critical parameter, the limit of chloride content shall be 0.05 percent and shall be required to be measured if desired by the purchaser.'

[*Page* 1, *Table* 1, *Sl No.* (iii), *col* 3] — Substitute '3.0' *for* '2'.

[*Page* 1, *Table* 1, *Sl No.* (iv), *col* 3] — Substitute '6.0' *for* '6'.

(*Page* 1, *Table* 1, *Notes* 3 *and* 4) — Delete.

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Substitute 'net mass' *for* 'average net mass' wherever it appears in the standard.

(*Cover page* 2, *para* 3 *of Foreword*) — Substitute the following for the existing text:

"Specific requirements of ordinary Portland cement for manufacture of railway sleepers to be designated as 43-S grade are given in the standard in **5.2**, **6.1**, **6.2.2**, **6.3**, **6.4** and **9.1**. To differentiate it with normal grade, '43-S grade' shall be marked on the bags/packages for such cement in place of '43-S grade'."

(*Page* **1**, *clause* **5**)— Insert a new clause **5.2** as follows:

'**5.2** Cement used for railway sleepers shall satisfy the following chemical/minerological requirements and shall be designated as 43-S grade:

i) Magnesia, percent by mass — Not more than 5.0

ii) Tricalcium aluminate content, percent — Not more than 10.0

iii) Tricalcium silicate, percent — Not less than 45'

(*Page* **1**, *clause* **6.1**) — Insert the following at the end of the clause:

'For 43-S grade cement, the specific surface shall not be less than 370 m^2/kg.'

(*Page* **1**, *Table* 1, *Note* 1) — Insert the following at the end:

'The tricalcium silicate content (C_3S) is calculated by the formula:

$C_3S = 4.07\,CaO - 7.60\,SiO_2 - 6.72\,Al_2O_3 - 1.43\,Fe_2O_3 - 2.85\,SO_3$ '

(*Page* **2**, *clause* **6.2.1.1**) — Insert a new clause **6.2.2** as follows:

'**6.2.2** For 43-S grade cement, soundness of unaerated cement when tested by the Le-Chatelier method shall not have an expansion of more than 5 mm.'

(*Page* 2, *clause* **6.3**) — Insert the following under (a) :

'Initial setting time for 43-S grade cement in minutes — Not less than 60.'

(*Page* 2, *clause* **6.4**) — Insert the following as new para:

'For 43-S grade cement, compressive strength at 168 ± 2 h shall not be less than 37.5 MPa.'

(*Page* 2, *clause* **9.1**, *line* 12) — Insert the following after '43 Grade Ordinary Portland cement':

''or '43-S Grade Ordinary Portland Cement', whichever is applicable.''

(CED 2)

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