IS 12600 : 1989
(Reaffirmed 1995

Indian Standard

PORTLAND CEMENT, LOW HEAT — SPECIFICATION

भारतीय मानक

पोर्टलैंड सीमेंट, अल्प ताप – विशिष्टि

UDC 666·942·33

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

January 1990

Price Group 4

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards on 20 June 1989, after the draft finalized by the Cement and Concrete Sectional Committee had been approved by the Civil Engineering Division Council.

The requirements of low heat Portland cement were earlier covered in IS 269 : 1976 'Specification for ordinary and low heat Portland cement (*third revision*)' which in addition, covered the requirements of ordinary Portland cement. Since the Sectional Committee decided to bifurcate the standard, the requirements of low heat Portland cement have now been covered in a separate specification.

This specification covers the requirements of low heat Portland cement as was given in IS 269 : 1976 with the various amendments published from time to time.

Low heat cement is particularly suited for making concrete for dams and many other types of water-retaining structures, bridge abutments, massive retaining walls, piers and slabs, etc. In mass concreting, there is often considerable rise in temperature because of the heat evolved as the cement sets and hardens, and the slow rate at which it is dissipated from the surface. The shrinkage which occurs on subsequent cooling sets up tensile stresses in the concrete which may result in cracking. The use of low heat cement is advantageous since it evolves less heat than ordinary Portland cement.

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

This standard contains clause **11.4.1** which gives option to the purchaser and clauses **6.5, 9.2.1** and **9.3** which call for agreement between the purchaser and the supplier.

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

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

PORTLAND CEMENT, LOW HEAT — SPECIFICATION

1 SCOPE

1.1 This standard covers the manufacture and chemical and physical requirements of low heat Portland cement for use where low heat of hydration is required, as in mass concrete for dams.

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 Low heat Portland cement 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 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.

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

5 CHEMICAL REQUIREMENTS

5.1 When tested in accordance with the methods given in IS 4032 : 1985, low heat Portland cement shall comply with the chemical requirements given in Table 1 and **5.2**.

5.2 The percentage of lime, after deduction of that necessary to combine with sulphuric anhydride percent, shall be:

a) not more than 2·4 (SiO_2) + 1·2 (Al_2O_3) + 0·65 (Fe_2O_3), and

b) not less than 1·9 (SiO_2) + 1·2 (Al_2O_3) + 0·65 (Fe_2O_3).

NOTE — Each symbol in brackets refers to the percentage (by mass of total cement) of the oxide excluding any contained in the insoluble residue referred to at Sl No. (ii) of Table 1.

Table 1 Chemical Requirements for Low Heat Portland Cement

(*Clauses* 5.1 *and* 5.2)

Sl No.	Characteristic	Requirement
i)	Ratio of percentage of alumina to that of iron oxide	Not less than 0·66
ii)	Insoluble residue, percent by mass	Not more than 4 percent
iii)	Magnesia, percent by mass	Not more than 6 percent
iv)	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
v)	Total loss on ignition	Not more than 5 percent

NOTES

1 The tri-calcium 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 percentage (by mass of total cement) of the oxide, excluding any contained in the insoluble residue referred at Sl No. (ii).

2 Alkali aggregate 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. Where, however, such cements are not available, use of Portland pozzolana cement or cement pozzolanic admixture is recommended.

3 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 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 be not less than 320 m^2/kg.

6.2 Soundness

6.2.1 When tested by '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 the cements, 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 60, and

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 $\left(\frac{P}{4}+3{\cdot}0\right)$ 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 10 MPa,

b) 168 ± 2 hours not less than 16 MPa, and

c) 672 ± 4 hours not less than 35 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 the order.

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

6.7 Heat of Hydration

When tested by the method described in IS 4031 (Part 9) : 1988, the heat of hydration of cement shall be as follows:

a) 7 days : not more than 272 kJ/kg, and

b) 28 days : not more than 314 kJ/kg.

7 STORAGE

7.1 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.

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 the 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), multi-wall 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 bag] bearing the manufacturer's name or his registered trade-mark, if any. The words 'low heat Portland cement' and the number of bags (net mass) to the tonne or the nominal 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 from 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 and 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

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 the 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 Identifying

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 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 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 instructions 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 the requirements of this standard, and

b) By the purchaser if the results show that the cement complies with the requirements of 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 the 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*
IS 650 : 1966	Standard sand for testing of cement (*first revision*)	IS 4905 : 1968	Methods for random sampling
IS 2580 : 1982	Jute sacking bags for packing cement (*second revision*)	IS 11652 : 1986	High density polyethylene (HDPE) woven sacks for packing cement
IS 3535 : 1986	Methods of sampling hydraulic cement (*first revision*)	IS 11653 : 1986	Polypropylene (PP) woven sacks for packing cement
IS 4031 (Parts 1 to 13)	Methods of physical tests for hydraulic cement	IS 11761 : 1986	Multi-wall paper sacks for cement, valved-sewn-gussetted type
IS 4032 : 1985	Method of chemical analysis of hydraulic cement (*first revision*)	IS 12154 : 1987	Light weight jute bags for packing cement
IS 4845 : 1968	Definitions and terminology relating to hydraulic cement	IS 12174 : 1987	Jute synthetic union bag for packing cement

ANNEX B

(*Clause* 9.2 and *Foreword*)

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. For methods of random sampling, IS 4905 : 1968 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 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 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 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 C

COMPOSITION OF THE TECHNICAL COMMITTEE

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BUREAU OF INDIAN STANDARDS

Headquarters :

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones : 331 01 31, 331 13 75

Telegrams : Manaksanstha
(Common to all Offices)

Regional Offices :	Telephone
Central : Manak Bhavan, 9 Bahadur Shah Zafar Marg NEW DELHI 110002	331 01 31 331 13 75
Eastern : 1/14 C. I. T. Scheme VII M, V. I. P. Road, Maniktola CALCUTTA 700054	36 24 99
Northern : SCO 445-446, Sector 35-C, CHANDIGARH 160036	2 18 43 3 16 41
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AMENDMENT NO. 1 JUNE 1991

TO

IS 12600 : 1989 PORTLAND CEMENT, LOW HEAT — SPECIFICATION

(*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 quantity in **9.2.2**."

(CED 2)

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AMENDMENT NO. 2 NOVEMBER 1991
TO
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(*Page* 4, *clause* B-1.2) — Substitute 'up to 25 tonnes' *for* ' of 20 to 25 tonnes'.

(CED 2)

Reprography Unit, BIS, New Delhi, India

AMENDMENT NO. 3 JUNE 1993
TO
IS 12600 : 1989 PORTLAND CEMENT, LOW HEAT — SPECIFICATION

[*Page* 3, *clause* **9.2.1.1** (*see also Amendment No.* 1)] — Substitute the following for the existing clauses **9.2.2** to **9.2.2.4**:

"**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)

Reprography Unit, BIS, New Delhi, India

AMENDMENT NO. 4 APRIL 2000
TO
IS 12600 : 1989 PORTLAND CEMENT, LOW HEAT — SPECIFICATION

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

(CED 2)

Reprography Unit, BIS, New Delhi, India

AMENDMENT NO. 5 APRIL 2002
TO
IS 12600 : 1989 PORTLAND CEMENT, LOW HEAT — SPECIFICATION

(*Page* 2, *clause* **6.3.1**, *line* 6) — Substitute 'less than' *for* 'not less than'.

(CED 2)

Reprography Unit, BIS, New Delhi, India