FOREWORD

This standard pertains to Portland Limestone Cement and covers the requirements such as its manufacture, chemical and physical requirements, packing and marking. It covers the requirements of materials, that is limestone and its proportions to be used in the manufacture of Portland Limestone cement.

Low clinker cements have been demonstrated to be technically and environmentally beneficial in many scenarios. The manufacture of Portland Limestone cement through inter-grinding of its components requires that sufficient care is taken to ensure that all constituents are ground to requisite fineness. Individual constituents, especially clinker, remaining coarse after grinding can significantly hamper the performance of the cement.

Portland Limestone Cement is not recommended for use in concrete in service of sulphate concentration severity class-3 and above as per IS 456:2000 and in service where temperature falls below 15^0C throughout the day for more than one month in a year. As a precautionary measure Portland Limestone Cement is not recommended for concrete when steam curing is to be employed.

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 C-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 13.2.2 which give option to the purchaser and the supplier; and Table 3, Sl No. (vi) and 10.2, 10.3, 10.4 and 10.4.3, which call for an agreement between the purchaser and the supplier.

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 of 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.

Draft Standard for
Portland Limestone Cement – Specification

1 SCOPE

This standard covers the manufacture, and chemical and physical requirements of Portland limestone 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 and the following shall apply.

3.1 Portland Limestone Cement – An intimately interground mixture of Portland cement clinker and limestone with addition of gypsum (natural or chemical) or an intimate and uniform blending of ordinary Portland cement and finely ground limestone with addition of ground gypsum, if required.

4 RAW MATERIAL

4.1 Limestone

The limestone used in the manufacture of Portland limestone cement shall contain at least 36 percent of CaO, and dolomite content shall not exceed 50 percent. The mass loss of the limestone shall be measured according to Annex B for calculation of CaO and MgO content.

Note: The percentage of dolomite is obtained by using equivalent MgO content in the chemical analysis of limestone. The chemical formula and atomic mass of dolomite mineral are $CaMg(CO_3)_2$ and 184 respectively. The formula for estimation of dolomite percentage using MgO content is given below.

$$Dolomite\ percentage = \ percentage\ of\ MgO \times \frac{Atomic\ mass\ of\ CaMg(CO_3)_2}{Atomic\ mass\ of\ MgO}$$

$$Dolomite\ percentage = \ percentage\ of\ MgO \times \ 4.6$$

4.2 Ground Limestone

When Portland Limestone cement is manufactured by intimately and uniformly blending ordinary Portland cement or clinker and ground limestone, the ground limestone shall have fineness not less than 700 m^2/kg, in order to utilise the beneficial effects of limestone addition in terms of its chemical, filler & nucleation effect and subsequently to compensate for dilution action.

4.3 Portland Cement Clinker

The Portland cement clinker used in the manufacture of the cement shall conform to IS 16353. When Portland Limestone cement is manufactured by intimately and uniformly blending Portland cement clinker and ground limestone, clinker shall be suitably ground, so that the Portland limestone cement produced shall conform to the requirements specified in Table 3.

4.4 Portland Cement

Portland cement for blending for manufacture of cement as per this standard shall conform to IS269. When Portland Limestone cement is manufactured by intimately and uniformly blending Portland cement and ground

limestone, the selected Portland Cement shall have adequate fineness, so that the Portland limestone cement produced shall conform to the requirements specified in Table 3.

5. Manufacture

5.1 Portland Limestone cement shall be manufactured either by,

a) intimately inter-grinding Portland cement clinker and limestone; or

b) intimately and uniformly blending ordinary Portland cement and ground limestone; with required addition of gypsum so as to produce a cement capable of complying with this standard, maintaining the proportion as given in Table 1. The homogeneity of the mixture shall be guaranteed within ±3% of the declared limestone addition in the same consignment.

5.2 When Portland limestone cement is obtained by grinding limestone with Portland cement clinker, no material shall be added, 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 limestone cement by blending process. Furthermore, when the grinding of the clinker is carried out along with limestone, care must be taken to ensure that a uniform fineness is achieved for all constituents of the cement, i.e. clinker and limestone.

Note - Additional measurements of retention on 90 µm and 45 µm sieves may be carried out to ensure that the cement is sufficiently well ground.

Table 1 Material Proportion to be Used in Portland Limestone Cement *(Clause 5.1)*

Sl No. **(1)**	**Material** **(2)**	**Proportion** **(Percent by Weight)** **(3)**
i)	Portland cement clinker Or Ordinary Portland cement	Minimum 80 (in case of clinker is used) Minimum 85 (in case of OPC is used)
ii)	Limestone	10-15

NOTE – Chemical gypsum shall be added provided that the 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 limestone cement, shall comply with the chemical requirements given in Table 2.

Table 2 Chemical Requirements for Portland Limestone Cement *(Clause 6.1)*

Sl No. **(1)**	**Characteristic** **(2)**	**Requirement** **(3)**
i)	Insoluble residue, percent by mass (Max)	8.0 *(to be discussed)*
ii)	Magnesia, percent by mass, *Max*	6.0
iii)	Total sulphur content calculated as sulphuric anhydrite (SO3), percent by mass, *Max*	3.5
iii)	Loss on ignition, percent by mass ,*Max*	12.0 *(to be discussed)*
iv)	Chloride content, percent by mass, Max	0.1 0.05 (For pre-stressed structures) *(to be discussed)*
v)	Alkali content	(see Note)

NOTE – 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 0.8 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.

7 PHYSICAL REQUIREMENTS

Portland Limestone cement shall comply with the physical requirements given in Table 3.

Table 3 Physical Requirements for Portland Limestone Cement *(Clause 7)*

Sl No. (1)	**Characteristic** (2)	**Requirement** (3)	**Method of Test , Ref to** (4)
i)	Fineness, m^2/kg, *Min*	450	IS 4031 (Part 2)
ii)	Soundness : a) By Le-Chatelier method, mm, *Max* b) By autoclave test method, percent, *Max*	 10 (see Note 1) 0.8	IS 4031 (Part 3)
iii)	Setting time : a) Initial, min, *Min* b) Final, min, *Max*	 30 (see Note 2) 600	IS 4031 (Part 5)
iv)	Compressive strength, MPa (see Note 3) : a) 72 ± 1 h, *Min* b) 168 ± 2 h, *Min* c) 672±4 h, *Min*	 23 33 43	IS 4031 (Part 6)
v)	Drying shrinkage, percent, *Max*	0.15	IS 4031 (Part 10)
vi)	Transverse strength (Optional)	See Notes 3, 4 & 5	IS 4031 (Part 8)

NOTES

1 In the event of cement failing to comply with one or both the requirements of soundness specified in the above table, further tests in respect of failure shall be made as described in IS4031 (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.

2 If cement exhibits false set, the ratio of final penetration measurement after 5min of completion of mixing period to the initial penetration measured exactly after 20 s of completion of mixing period, expressed as percent, shall not be 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 IS4031 (Part 5) after breaking the false set, shall confirm to the value given in the above table.

3 For measurement of the compressive and transverse strength of the cement, the specimens shall be cured under conditions specified in IS 4031 (Part 6).

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.

5 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.

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 minimised warehouse deterioration (*see also* IS4802).

9 MANUFACTURER'S CERTIFICATE

9.1. The manufacturer shall satisfy himself that the cement conforms to the requirements of this standards 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). The type and percentage addition of performance improver(s) shall also be indicated in the certificate.

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

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) HDE/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 C.

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 C 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 packs 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 for 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 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.

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 Limestone Cement’;
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; and
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
i) Percentage of limestone addition.

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 the 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 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 IS3535.

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 enquirer 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 purchasers, 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	Ordinary portland cement — Specification (*sixth revision*)
2580 : 1995	Textiles - Jute sacking bags for packing cement - Specification (*third revision*)
3535 : 1986	Methods of sampling hydraulic cement
4031 (Part 2) : 1999 (Part 3) : 1988 (Part 5) : 1988 (Part 6) : 1988 (Part 8) : 1988 (Part 10) : 1988	Methods of physical tests for hydraulic cement: Part 2 Determination of fineness by Blaine air permeability method (*second revision*) Part 3 Determination of soundness (*first revision*) Part 5 Determination of initial and final setting times (*first revision*) Part 6 Determination of compressive strength of hydraulic cement (other than masonry cement) (*first revision*) Part 8 Determination of transverse and compressive strength of plastic mortar using prism (*first revision*) Part 10 Determination of drying shrinkage (*first revision*)
4032 : 1985	Method of chemical analysis of hydraulic cement (*first revision*)
4082 : 1996	Recommendations on staking and storage of construction materials and components at site (*second revision*)
4845 : 1968	Definitions and terminology relating to hydraulic cement
4905 : 1968	Methods of random sampling
11652 : 2017	Textiles — High density polyethylene (hdpe)/ polypropylene (pp) woven sacks for packaging of 50 kg cement — Specification (*third revision*)
11761 : 1997	Multi-wall paper sacks for cement — Specification (*first revision*)
12154 : 1987	Specification for light weight jute bags for packing cement
12174 : 1987	Specification for jute synthetic union bags for packing cement
16353 : 2015	Portland cement clinker — Specification

Annex B

(*Clause* 4.1)

DETERMINATION OF APPROXIMATE CALCIUM OXIDE AND MAGNESIUM OXIDE CONTENT IN LIMESTONE

(to be worked out)

B-2 APPARATUS

(to be worked out)

B-3 PROCEDURE

(to be worked out)

ANNEX C

(*Foreword and Clause* 10.1.1)

TOLERANCE REQUIREMENTS FOR THE QUANTITY OF CEMENTPACKED IN BAGS

C-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 maybe referred to.

C-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 for cement in the bag.

C-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 hold50 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.

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