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भाग १ फ्लाई-ऐश आधारित

(तीसरा पुनरीक्षण)

Indian Standard

PORTLAND-POZZOLANA CEMENT — SPECIFICATION

PART 1 FLY ASH BASED

(*Third Revision*)

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

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FOREWORD

This Indian Standard (Part 1) (Third 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.

Portland-pozzolana cement can be produced either by grinding together Portland cement clinker and pozzolana with addition of gypsum or calcium sulphate, or by intimately and uniformly blending Portland cement and fine pozzolana. While grinding of the two materials together presents no difficulty, the mixing of dry powders intimately is extremely difficult. The blending method should, therefore, be resorted to only when the grinding method is impossible or proves uneconomical in a particular case. Where blending method is adopted, every care should be taken to see that the blending is as intimate as possible. Generally, if the blending is not uniform, it is reflected in the performance tests. The Sectional Committee responsible for the preparation of this specification is of the opinion that the blending method should be confined to such factories/ works where intimate and uniform blending is feasible with the employment of requisite machinery so as to ensure uniformity of product and its guaranteed performance.

Portland-pozzolana cement produces less heat of hydration and offers greater resistance to the attack of aggressive waters than normal Portland cement. Moreover, it reduces the leaching of calcium hydroxide liberated during the setting and hydration of cement. It is particularly useful in marine and hydraulic construction and other mass concrete structures. Portland-pozzolana cement can generally be used wherever 33 grade ordinary Portland cement is usable under normal conditions. However, it should be appreciated that all pozzolanas need not necessarily contribute to strength at early ages. In view of this fact, this specification has been prepared to enable manufacturers to produce Portland-pozzolana cement equivalent to 33 grade ordinary Portland cement on the basis of the 3, 7 and 28-days compressive strength.

For construction of structures using rapid construction methods like slipform construction, Portland-pozzolana cement shall be used with caution since 4 to 6h strength of concrete is considered significant in such construction.

This standard was first published in 1962 and subsequently revised in 1967 and 1976. In this revision the standard has been split into two parts based on the pozzolana used in the manufacture of such cements in view of the special needs of some hydraulic structures which require pozzolana cement manufactured only with fly ash pozzolana, This would also enable the user to identify the pozzolana used in the manufacture of cement. Part 1 of this standard covers pozzolana cement manufactured by using only fly ash pozzolana and Part 2 covers pozzolana cement manufactured by using either calcined clay or a mixture of calcined clay and fly ash as pozzolana.

In this revision both chemical and physical requirements have been kept the same as was given in 1976 version of this standard as amended. Various requirements of Portland-pozzolana cement given in 1976 version of this standard had been modified from time to time by issuing amendments based on the experience gained with the use of the standard and the requirements of the users and also keeping in view raw materials and fuel available in the country for manufacture of cement. The important amendments include lowering the value of compressive strength in lime reactivity test from 5 MPa to 4 MPa, incorporating a value of 3-days compressive strength as 16 MPa, modifying the requirement of sulphuric anhydride (SO_3) and insoluble residue, deleting the requirement of pozzolanicity test, increasing the value of 28-days compressive strength from 31 MPa to 33 MPa, making autoclave soundness test compulsory irrespective of the magnesia content in cement, incorporating a provision for retest in respect of autoclave soundness test after aeration of the cement, incorporating a clause on false set of cement and permitting packaging of cement in 25 kg bags. All these amendments have been taken care of in this revision.

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). Any modification in these rules in respect of tolerance on mass of cement would apply automatically to this standard.

This standard contains clauses **4.1.4**, **4.2** and **12.4.1** which permit the purchaser to use his option and **10.2. 1** and **10. 3** call for agreement between the purchaser and the manufacturer.

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, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

PORTLAND-POZZOLANA CEMENT — SPECIFICATION

PART 1 FLY ASH BASED

(*Third Revision*)

1 SCOPE

This standard (Part 1) covers the manufacture, physical and chemical requirements of Portland-pozzolana cement using only fly ash pozzolana.

2 REFERENCES

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

3 TERMINOLOGY

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

3.1 Pozzolana

An essentially silicious material which while in itself possessing little or no cementitious properties will, in finely divided form and in the presence of water, react with calcium hydroxide at ambient temperature to form compounds possessing cementitious properties. The term includes natural volcanic material having pozzolanic properties as also other natural and artificial materials, such as diatomaceous earth, calcined clay and fly ash.

3.2 Portland Clinker

Clinker, consisting mostly of calcium silicates, obtained by heating to incipient fusion, a predetermined and homogeneous mixture of materials principally containing lime (CaO) and silica (SiO_2) with a smaller proportion of alumina (Al_2O_3) and iron oxide (Fe_2O_3).

3.3 Portland-Pozzolana Cement

An intimately interground mixture of Portland clinker and pozzolana with the possible addition of gypsum (natural or chemical) or an intimate and uniform blending of Portland cement and fine pozzolana.

4 RAW MATERIAL

4.1 Pozzolana

4.1.1 Fly ash used in the manufacture of Portland-pozzolana cement shall conform to IS 3812 : 1981 subject to the requirements specified in **4.1.2** and **4.1.3**.

4.1.2 Fineness and average compressive strength in lime reactivity of fly ash that is to be blended with finished Portland cement to produce Portland-pozzolana cement, when tested in accordance with the procedure specified in IS 1727 : 1967, shall not be less than 320 m^2/kg and 4·0 MPa respectively. Average compressive strength in lime reactivity test of such fly ash shall be carried out at the fineness at which pozzolana has been received for blending.

4.1.3 Average compressive strength in lime reactivity of fly ash that is to be interground with Portland cement clinker for manufacture of Portland-pozzolana cement shall not be less than 4·0 MPa when tested at the fineness of Portland-pozzolana cement manufactured out of it or at the fineness in 'as-received' condition, whichever is greater, in accordance with the procedure specified in IS 1727 : 1967.

4.1.4 The purchaser shall have the right, if he so desires to obtain samples of fly ash used in the manufacture of Portland-pozzolana cement for purposes of checking its conformity to the requirements specified in **4.1.1** to **4.1.3**.

4.2 Portland Cement Clinker

The Portland cement clinker used in the manufacture of Portland-pozzolana cement shall comply in all respects with the chemical requirements of IS 269 : 1989 and the purchaser have the right, if he so desires to obtain sample of the clinker used in the manufacture for purposes of checking its conformity to IS 269 : 1989.

4.3 Portland Cements

Portland cement for blending with fly ash shall conform to IS 269 : 1989.

4.4 Other Admixtures

When Portland-pozzolana cement is obtained by grinding fly ash with Portland cement clinker, no material other than gypsum (natural or chemical) or water or both, shall be added. Such air-entraining agents or surfactants which have been proved harmless may be added in quantities not exceeding one percent.

5 MANUFACTURE

Porland-pozzolana cement shall be manufactured either by intimately intergrinding Portland

cement clinker and fly ash or by intimately and uniformly blending Portland cement and fine fly ash. For blending of Portland cement and fly ash, the method and equipment used shall be the one well accepted for achieving a complete uniform and intimate blending. The blending operation shall be a properly designed and well defined unit operation in approved blenders. Gypsum (natural or chemical) may be added if the Portland-pozzolana cement is made by intergrinding Portland cement clinker with fly ash. The fly ash constituent shall not be less than 10 percent and not more than 25 percent by mass of Portland-pozzolana cement. The homogeneity of the mixture shall be guaranteed within ±3 percent in the same consignment.

6 CHEMICAL REQUIREMENTS

6.1 Portland-pozzolana cement, shall comply with the chemical requirements given in Table 1.

Table 1 Chemical Requirements of Portland-Pozzolana Cement

Sl No.	Characteristic	Requirement	Method of Test Ref to IS
(1)	(2)	(3)	(4)
i)	Loss on ignition, percent by mass, *Max*	5·0	4032 : 1985
ii)	Magnesia (MgO), percent by mass, *Max*	6·0	4032 : 1985
iii)	Sulphuric anhydride (SO_3), percent by mass, *Max*	3·0	4032 : 1985
iv)	Insoluble material, percent by mass, *Max*	$x+\frac{4{\cdot}0\,(100-x)}{100}$ where x is the declared percentage of flyash in the given Portland-pozzolana cement	4032 : 1985

7 PHYSICAL REQUIREMENTS

7.1 Fineness

When tested by the air permeability method described in IS 4031 (Part 2) : 1988, the specific surface of Portland-pozzolana cement shall be not less than 300 m^2/kg.

7.2 Soundness

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

7.2.1.1 In the event of cement failing to comply with any or both the requirements specified in **7.2.1**, 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 cement so aerated shall be not more than 5 mm and 0·6 percent when tested by 'Le-Chatelier' method and autoclave test respectively as described in IS 4031 (Part 3) : 1988.

7.3 Setting Time

The setting time of Portland-pozzolana cement, when tested by the Vicat apparatus method described in IS 4031 (Part 5) : 1988, shall be as follows:

Initial setting time	30 min, *Min*
Final setting time	600 min, *Max*

7.3.1 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 when tested by the method described in IS 4031 (Part 14) : 1989. 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 **7.3**.

7.4 Compressing Strength

7.4.1 The average compressive strength of not less than three mortar cubes (area of face 50 cm^2) composed of one part of cement, three parts of standard sand (*see* Note 2) by mass, and $P/4 + 3{\cdot}0$ percent (of combined mass of cement and sand) water, and prepared, stored and tested in the manner described in IS 4031 (Part 6) : 1988 shall be as follows:

a) At 72 ± 1 h	16 MPa, *Min*
b) At 168 ± 2 h	22 MPa, *Min*
c) At 672 ± 4 h	33 MPa, *Min*

NOTES

1 P is the percentage of water required to produce a paste of standard consistency (*see* **12.3**).

2 Standard sand shall conform to IS 650 : 1966.

7.4.2 Notwithstanding the cubes satisfying the strength requirements specified in **7.4.1**, they shall also show a progressive increase in strength from the strength at 72 h.

7.5 Drying Shrinkage

The average drying shrinkage of mortar bars prepared and tested in accordance with IS 4031 (Part 10) : 1988 shall not be more than 0·15 percent.

8 STORAGE

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

9 MANUFACTURER'S CERTIFICATE

9.1 The manufacturer shall satisfy himself that the cement conforms to the requirements of this standard. The manufacturer shall also furnish within ten days of despatch of cement, a certificate indicating the percentage of fly ash. The manufacturer shall also state in the certificate that the amount of fly ash in the finished cement is not varying more than ±3 percent from the value so declared.

9.2 The certificate furnished shall also indicate the total chloride content in percent by mass of cement.

NOTES

1 Total chloride content in cement shall not exceed 0·05 percent by mass for cement used in long span reinforced concrete structures, when determined by the method given in IS 12423 : 1988.

2 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.

10 DELIVERY

10.1 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. The words 'Portland-pozzolana cement — fly ash based' or a bright colour band to distinguish Portland fly ash pozzolana cement from other cements and the number of bags (net mass) to the tonne or the nominal average net mass (*see* **10.2**) of the cement shall be legibly and indelibly marked on each bag. Bags shall be in good condition at the time of inspection.

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

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

10.2.1 The average net mass of cement per bag may also be 25 kg subject to tolerances as given in **10.2.1.1** and packed in suitable bags as agreed to between the purchaser and the manufacturer.

10.2.1.1 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.

10.2.2 When cement is intended for export and if the purchaser so requires, packing of cement may be done in bags with an average net mass per bag as agreed to by the purchaser and the manufacturer.

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

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

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

10.2.2.4 The tolerance requirements for the mass of cement packed in bags shall be as given in **10.2.1.1** except the average net mass which shall be equal to or more than the quantity in **10.2.2.**

10.3 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.

11 SAMPLING

11.1 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 works 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 till such time, they are tested.

11.2 In addition to the requirements of **11.1** the methods and procedure of sampling shall be in accordance with IS 3535 : 1986.

11.3 Facilities for Sampling and Identifying

The manufacturer or supplier shall afford every facility, including labour and materials for taking and packing the samples for testing the cement and for subsequent identification of the cement sampled.

12 TESTS

12.1 The sample or samples of pozzolana cement drawn as described in 11 shall be tested as per methods referred to in relevant clauses.

12.2 The temperature for carrying out physical tests shall, as far as possible, be 27±2°C. However, the actual temperature during the testing shall be recorded.

12.3 Consistency of Standard Cement Paste

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

12.4 Independent Testing

12.4.1 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.

12.4.2 *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.

13 REJECTION

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

13.2 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 in this specification.

ANNEX A

(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*	*IS No.*	*Title*
269 : 1989	Specification for 33 grade ordinary Portland cement (*fourth revision*)	4845 : 1968	Definitions and terminology relating to hydraulic cement
650 : 1966	Specification for standard sand for testing of cement (*first revision*)	4905 : 1968	Methods for random sampling
1727 : 1967	Methods of tests for pozzolanic materials (*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
3812 : 1981	Specification for fly ash for use as pozzolana and admixture (*first revision*)	12089 : 1987	Specification for granulated slag for the manufacture of Portland slag cement
4031 (Parts 1 to 14)	Methods of physical tests for hydraulic cement	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
		12423 : 1988	Method for colorimetric analysis of hydraulic cement

ANNEX B

(*Clause* 10.2)

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 sample shall be as given below:

Batch Size	*Sample Size*
100 to 150	20
151 ,, 280	32
281 ,, 500	50
501 ,, 1 200	80
1 201 ,, 3 200	125
3 201 and above	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 and 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

(*Foreword*)

COMPOSITION OF THE TECHNICAL COMMITTEE

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SHRI N. C. BANDYOPADHYAY
Joint Director (Civil Engg), BIS

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AMENDMENT NO. 1 NOVEMBER 1991
TO
IS 1489 (Part 1) : 1991 PORTLAND - POZZOLANA CEMENT — SPECIFICATION
PART 1 FLY ASH BASED

(Third Revision)

(*Page* 5, *clause* B-1.2) — Substitute 'up to 25 tonnes' *for* 'of 20 to 25 tonnes'.

(CED 2)

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AMENDMENT NO. 2 JUNE 1993
TO
IS 1489 (Part 1) : 1991 PORTLAND-POZZOLANA CEMENT — SPECIFICATION

PART 1 FLY ASH BASED

(Third Revision)

(*Page* 3, *clauses* **10.2.2** *to* **10.2.2.4**) — Substitute the following for the existing clauses:

"**10.2.2** 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.

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

10.2.2.2 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.

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

10.2.2.4 The tolerance requirements for the mass of cement packed in bags/drum shall be as given in **10.2.1.1** except the average net mass which shall be equal to or more than the quantity in **10.2.2.**"

(CED 2)

Reprography Unit, BIS, New Delhi, India

AMENDMENT NO. 3 JULY 2000
TO
IS 1489 (Part 1) : 1991 PORTLAND-POZZOLANA CEMENT — SPECIFICATION

PART 1 FLY ASH BASED

(Third Revision)

Substitute 'net mass' *for* 'nominal average net mass' and 'average net mass' wherever these appear in the standard.

(*Page* 2, *clause* 5, *last but one sentence*) — Substitute the following for the existing sentence:

'The fly ash constituent shall be not less than 15 percent and not more than 35 percent by mass of Portland-pozzolana cement.'

(CED 2)

Reprography Unit, BIS, New Delhi, India