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(Reaffirmed 1992)

Indian Standard

**SPECIFICATION FOR
FLY ASH FOR USE AS POZZOLANA
AND ADMIXTURE**

(*First Revision*)

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**BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002**

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FLY ASH FOR USE AS POZZOLANA
AND ADMIXTURE
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0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Indian Standards Institution on 27 February 1981, after the draft finalized by the Pozzolana Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 Fly ash is a finely divided residue resulting from the combustion of ground or powdered bituminous coal or sub-bituminous coal (lignite) and transported by the flue gases of boilers fired by pulverized coal or lignite. It is available in large quantities in the country as a waste product from a number of thermal power stations and industrial plants using pulverized coal or lignite as fuel for the boilers. The effective use of fly ash as a pozzolana in the manufacture of cement and for part replacement of cement, as an admixture in cement mortar and concrete and in lime pozzolana mixture, has been established in the country in recent years. Recent investigations on Indian fly ashes have indicated greater scope for their utilization as a construction material. Greater utilization of fly ash will lead to not only saving of scarce construction materials but also assist in solving the problem of disposal of this waste product from thermal power stations. The recent investigations have also indicated the necessity to provide proper collection methods for fly ash so as to yield fly ash of quality and uniformity which are prime requirements of fly ash for use as a construction material. This standard has been prepared to give general guidance towards the suitability of fly ash as a pozzolana and as an admixture for structural mortar and concrete.

0.3 This standard was first published in 1966 in three parts: Part I covering use of fly ash as a pozzolana, Part II covering use of fly ash as an admixture, and Part III covering use of fly ash as a fine aggregate to cater to the requirements of fly ash for three specific uses. The Sectional Committee responsible for the formulation of this standard subsequently felt that the performance of fly ash as a pozzolana or an admixture or a

fine aggregate, was complementary and not separable and hence requirements of fly ash for these uses should be covered by a single specification. The Sectional Committee, therefore, decided to revise IS : 3812 (Part I)-1966*, IS : 3812 (Part II)-1966† and IS : 3812 (Part III)-1966‡ by combining them into a single specification with modifications found necessary due to the experience gained from the use of these specifications and to update them based on the current knowledge on the subject.

0.4 This standard covers the extraction and physical and chemical requirements of fly ash for use as pozzolana for part replacement of cement, for use with lime, for use as an admixture and for the manufacture of Portland pozzolana cement. Apart from the major modification mentioned in **0.3**, in this revision, fly ash has been classified into two grades based on its end use and the chemical and physical requirements have been modified and provided accordingly. Other modifications include deletion of provision on uniformity requirements; reference to latest Indian Standards for terminology, tests, sampling and storage; and use of SI units.

0.5 There is sufficient evidence to indicate that fly ash with loss on ignition value up to 12 percent may be used for replacement of cement.

0.6 Use of fly ash as a part replacement of cement and as an admixture has been mentioned in IS : 456-1978§, IS : 4098-1967|| covers the requirements of lime pozzolana mixture manufactured by intergrinding or blending lime and fly ash conforming to this standard. IS : 1489-1976¶ covers the requirements of Portland pozzolana cement manufactured either by intergrinding Portland cement clinker and fly ash with addition of gypsum, or by blending Portland cement and fly ash.

0.7 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**. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Specification for fly ash: Part I For use as pozzolana.

†Specification for fly ash: Part II For use as admixture for concrete.

‡Specification for fly ash: Part III For use as fine aggregate for mortar and concrete.

§Code of practice for plain and reinforced concrete (*third revision*).

||Specification for lime-pozzolana mixture.

¶Specification for Portland pozzolana cement (*second revision*).

**Rules for rounding off numerical values (*revised*).

1. SCOPE

1.1 This standard covers the extraction and the physical and chemical requirements of fly ash for use as a pozzolana for part replacement of cement, for use with lime, for use as an admixture and for the manufacture of Portland pozzolana cement conforming to IS : 1489-1976*.

2. TERMINOLOGY

2.1 For the purpose of this standard, the definitions given in IS : 4305-1967† shall apply.

3. DESIGNATION

3.1 Fly ash shall be supplied in the following grades corresponding to the properties specified in 5 and 6:

<i>Grade Designation</i>	<i>General Use</i>
Grade I	For incorporation in cement mortar and concrete and in lime pozzolana mixture, and for manufacture of Portland pozzolana cement
Grade II	For incorporation in cement mortar and concrete and in lime pozzolana mixture

NOTE — Fly ash of grade II also may be used for manufacture of Portland pozzolana cement subject to the requirements of IS : 1489-1976*.

4. EXTRACTION OF FLY ASH

4.1 Fly ash may be extracted from flue gases of ground or pulverized coal or lignite fired boilers by any suitable process, such as by cyclone separation or electrostatic precipitation; bottom ash from the boilers shall not be added to the fly ash.

NOTE 1 — *Cyclone Separator* — A device in which the fly ash is separated by centrifugal force from the gas stream which is fed tangentially at high speed into a cylindrical shell and allowed to follow a helical path. Fly ash deposits on the sides of the cylinder and slowly slides down and collects at the bottom, from where it is removed.

NOTE 2 — *Electro-precipitator* — A device in which electrical charge is induced on fly ash particles which are subsequently removed from the gas stream under the influence of lateral electrical field.

*Specification for Portland pozzolana cement (*second revision*).

†Glossary of terms relating to pozzolana.

5. CHEMICAL REQUIREMENTS

5.1 Fly ash, when tested in accordance with the methods of test specified in IS : 1727-1967*, shall conform to the chemical requirements given in Table 1.

TABLE 1 CHEMICAL REQUIREMENTS

Sr. No.	CHARACTERISTIC	REQUIREMENT
(1)	(2)	(3)
i)	Silicon dioxide (SiO_2) plus aluminium oxide (Al_2O_3) plus iron oxide (Fe_2O_3), percent by mass, <i>Min</i>	70.0
ii)	Silicon dioxide (SiO_2), percent by mass, <i>Min</i>	35.0
iii)	Magnesium oxide (MgO), percent by mass, <i>Max</i>	5.0
iv)	Total sulphur as sulphur trioxide (SO_3), percent by mass, <i>Max</i>	2.75
v)	Available alkalis as sodium oxide (Na_2O), percent by mass, <i>Max</i> (see Note 1)	1.5
vi)	Loss on ignition, percent by mass, <i>Max</i>	12.0

NOTE 1 — Applicable only when reactive aggregates are used in concrete and are specially requested by the purchaser.

NOTE 2 — For determination of available alkalis, IS : 4032-1968 ' Method of chemical analysis of hydraulic cement' shall be referred to.

5.2 Limits regarding moisture content of fly ash shall be as agreed to between the purchaser and the supplier. All tests for the properties specified in 5.1 shall, however, be carried out on oven dry samples.

6. PHYSICAL REQUIREMENTS

6.1 Fly ash, when tested in accordance with the methods of test specified in IS : 1727-1967*, shall conform to the physical requirements given in Table 2.

6.2 Notwithstanding the strength requirements specified in Table 2, mixes in which fly ash is incorporated shall show a progressive increase in strength.

7. STORAGE

7.1 Fly ash shall be stored in such a manner as to permit easy access for proper inspection and identification of each consignment.

NOTE 1 — For guidance on storage at site, IS : 4082-1977† may be referred to.

NOTE 2 — Lignite fly ash shall be stored in a suitable weather-tight building to protect the fly ash from dampness and to minimize warehouse deterioration.

*Methods of test for pozzolanic materials (*first revision*).

†Recommendations on stacking and storage of construction materials at site (*first revision*).

TABLE 2 PHYSICAL REQUIREMENTS

(Clauses 6.1 and 6.2)

Sl No.	CHARACTERISTIC	REQUIREMENT GRADE OF FLY ASH	
		I	II
(1)	(2)	(3)	(4)
i)	Fineness — Specific surface in m^2/kg by Blaine's permeability method, <i>Min</i>	320	250
ii)	Lime reactivity — Average compressive strength in N/mm^2 , <i>Min</i>	4.0	3.0
iii)	Compressive strength at 28 days in N/mm^2 , <i>Min</i>	Not less than 80 percent of the strength of corresponding plain cement mortar cubes	
iv)	Drying shrinkage, percent, <i>Max</i>	0.15	0.10
v)	Soundness by autoclave test expansion of specimens, percent, <i>Max</i>	0.8	0.8

8. MANUFACTURER'S CERTIFICATE

8.1 The supplier/manufacturer shall satisfy himself that the fly ash conforms to the requirements of this standard, and if mutually agreed upon shall furnish a certificate to this effect to the purchaser or his representative.

9. DELIVERY

9.1 The supplier, while quoting the rates of fly ash, shall also indicate the moisture content of the fly ash to be supplied by him.

9.2 Supplies of fly ash may be made in bulk in suitable quantities mutually agreed upon between the purchaser and the supplier. Where so required by the purchaser, the fly ash may also be supplied in bags (jute, jute-laminated, multiply paper or polyethylene lined) bearing the net mass, supplier's name or registered trade-mark, if any. The tolerance on the mass of fly ash in each bag or consignment shall be as mutually agreed upon between the purchaser and the supplier.

9.3 The consignment may also be marked with the Standard Mark.

NOTE — 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 Standard Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well defined system of inspection, testing and quality control which is devised and supervised by BIS and operated by the producer. Standard marked products are also continuously checked by BIS for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

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 fly ash is required or by the latter's representative.

10.2 In addition to the requirements of **10.1**, the methods and procedure of sampling shall be in accordance with IS : 6491-1972*.

10.3 Facilities for Sampling and Identifying — The supplier shall afford every facility, and shall provide all labour and materials for taking and packing the samples for testing the fly ash and for subsequent identification of fly ash sampled.

11. TESTS

11.1 The sample or samples of fly ash for test shall be taken as described in **10** and shall be tested in accordance with IS : 1727-1967†.

11.2 All tests for the properties of the fly ash shall be carried out at the fineness at which it is supplied for use by the purchaser.

11.3 Independent Testing

11.3.1 If the purchaser or his representative requires independent test, 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.

*Methods of sampling fly ash.

†Methods of test for pozzolanic materials (*first revision*).

11.3.2 Cost of Testing — The supplier shall supply, free of charge, the fly ash required for testing. Unless otherwise specified in the enquiry and order, the cost of the tests shall be borne as follows:

- a) by the supplier if the results show that the fly ash does not comply with the requirements of this standard, and
- b) by the purchaser if the results show that the fly ash complies with the requirements of this standard.

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

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