

IS : 4031 (Part 12) - 1988
(Reaffirmed 1995)

Indian Standard

**METHODS OF PHYSICAL TESTS FOR
HYDRAULIC CEMENT**

**PART 12 DETERMINATION OF AIR CONTENT OF
HYDRAULIC CEMENT MORTAR**

(First Revision)

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

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METHODS OF PHYSICAL TESTS FOR HYDRAULIC CEMENT

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(*First Revision*)

0. FOREWORD

0.1 This Indian Standard (Part 12) (First Revision) was adopted by the Bureau of Indian Standards on 22 April 1988, after the draft finalized by the Cement and Concrete Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 Standard methods of testing cement are essential adjunct to the cement specifications. This standard in different parts lays down the procedure for the tests to evaluate the physical properties of different types of hydraulic cements. The procedure for conducting chemical tests of hydraulic cement is covered in IS : 4032-1985*.

0.3 Originally all the tests to evaluate the physical properties of hydraulic cements were covered in one standard; but for facilitating the use of this standard and future revisions, it has been decided to print the different tests as different parts of the standard and accordingly, this revised standard has been brought out in thirteen parts. This will also facilitate updating

of individual tests. Further, since publication of the original standard in 1968, a number of standards covering the requirements of different equipment used for testing of cement, a brief description of which was also covered in the standard, had been published. In this revision, therefore, reference is given to different instrument specifications deleting the description of the instruments, as it has been recognized that reproducible and repeatable test results can be obtained only with standard testing equipment capable of giving desired level of accuracy. This part (Part 12) covers determination of air content of hydraulic cement mortar.

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

*Method of chemical analysis of hydraulic cement (*first revision*).

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

1. SCOPE

1.1 This standard (Part 12) covers the procedure for determination of air content of hydraulic cement mortar for evaluating the properties of masonry cement or masonry mortars.

2. SAMPLING AND SELECTION OF TEST SPECIMENS

2.1 The samples of the cement shall be taken in accordance with the requirements of IS : 3535-1986* and the relevant standard specification for the type of cement being tested. The representative sample of the cement selected as above shall be thoroughly mixed before testing.

*Methods of sampling hydraulic cements (*first revision*).

3. TEMPERATURE AND HUMIDITY

3.1 The temperature of moulding room, dry materials and water shall be maintained at $27 \pm 2^\circ\text{C}$. The relative humidity of the laboratory shall be 65 ± 5 percent.

4. GENERAL

4.1 Standard Sand — The standard sand to be used in the test shall conform to IS : 650-1966*.

5. APPARATUS

5.1 Cylinder Measure — Cylinder measure and accessories conforming to IS : 11263-1985†.

*Specification for standard sand for testing of cement (*first revision*).

† Specification for cylinder measures for determination of air content of hydraulic cement mortar.

5.2 Balance — The balance used in weighing materials shall conform to the following requirements:

On balance in use, the permissible variation at a load of 1 000 g shall be ± 1.0 g. The permissible variation on new balance shall be one-half of this value. The sensibility reciprocal shall be not greater than twice the permissible variation.

NOTE 1 — The sensibility reciprocal is generally defined as the change in load required to change the position of rest of the indicating element or the elements of a non-automatic indicating scale a definite amount at any load.

NOTE 2 — Self-indicating balance with equivalent accuracy may also be used.

5.3 Standard Weights — The permissible variations on weights in use in weighing the cement shall be as prescribed in Table 1.

TABLE 1 PERMISSIBLE VARIATION ON WEIGHTS

WEIGHT	PERMISSIBLE VARIATION ON WEIGHTS IN USE PLUS OR MINUS
g	g
500	0.35
300	0.30
250	0.25
200	0.20
100	0.15
50	0.10
20	0.05
10	0.04
5	0.03
2	0.02
1	0.01

5.4 Planetary Mixer — Planetary mixer conforming to IS : 10890-1984*.

5.5 Flow Table and Accessories — Flow table and accessories conforming to IS : 5512-1983†.

5.6 Tamping Rod — Tamping rod conforming to 6.1 (c) of IS : 10086-1982‡.

6. PROCEDURE

6.1 Preparation of Mortar — Prepare mortar for the air entrainment test as given in 7 of IS : 4031 (Part 7)-1988§ except that the amount of water used for gauging shall be such as to produce a flow of 80 to 95 percent with 10 drops in six seconds.

6.2 Determination of Mass of 400 ml of Mortar — When the quantity of mixing water to produce a flow of 80 to 95 percent (with 10 drops in 6 s) has been found, return the mortar on the flow table to the bowl and remix for 15 s with the remainder of the mortar, using the

*Specification for planetary mixer used in tests of cement and pozzolana.

†Specification for flow table for use in tests of hydraulic cements and pozzolanic materials (first revision).

‡Specification for moulds for use in tests of cement and concrete.

§ Methods for physical tests for hydraulic cement : Part 7 Determination of compressive strength of masonry cement (first revision).

mixer at slow speed (140 ± 5 rev/min). Immediately determine the mass of 400 ml of mortar. Place the mortar gently in the 400 ml measure in three equal layers, spading each layer thoroughly with the spatula around the inner surface of the measure. In spading the first layer, do not strike the spatula forcibly against the bottom of the measure. In spading the second and final layers, use only enough force to cause the spatula to penetrate the surface of the previous layer. After the measure has been filled and spaded in the above manner, tap the sides of the measure lightly with the flat side of the tapping stick once each at five different points at approximately equal spacing around the outside of the measure in order to expel entrapped air. Take care that no space is left between the mortar and the inner surface of the measure as a result of the spading operation. Then cut the mortar off to a plane surface, flush with the top of the measure, by drawing the straight edge with a sawing motion across the top of the measure, making two passes over the entire surface, the second pass being made at right angles to the first. Take care in the striking off operation so that no loose sand grains cause the straight edge to ride above the top surface of the measure. Complete the entire operation of filling and striking off the measure within one and a half minute. Wipe off all mortar and water adhering to the outside of the measure. Weigh the measure and its contents (see Note). Record the mass of the mortar in grams, after subtracting the mass of the container.

NOTE — This operation may be facilitated by placing the measure on a steady flat-surfaced support of lesser diameter than the measure while filling and wiping.

6.3 Determination of Density of Cement — Determine the density cement in the usual manner by the displacement of liquid in a Le Chatelier flask as described in IS : 4031 (Part 11) - 1988*.

7. CALCULATION

7.1 Calculate the air content of the mortar and report it to the nearest 0.1 percent, using the following formulae:

$$A = 100 - \frac{M_m}{4}, \text{ and}$$

$$D = \frac{M_1 + M_2 + V_w}{\frac{M_1}{S_1} + \frac{M_2}{S_2} + V_w}$$

where

A — percentage of entrained air by volume,

M_m = mass of 400 ml of mortar in g,

D = density of air-free mortar,

M_1 = mass of cement in g,

M_2 = mass of standard sand in g,

V_w = volume of water used in cm^3 ,

S_1 = density of cement, and

S_2 = density of standard sand.

*Methods of physical tests for hydraulic cement : Part 11 Determination of density (first revision).