
**Test methods for sprayed concrete —
Part 1:
Flash setting accelerating admixtures
— Setting time**

Méthodes d'essai pour le béton projeté —

Partie 1: Adjuvants activateurs — Temps de prise

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 71, *Concrete, reinforced concrete and pre-stressed concrete*, Subcommittee SC 1, *Test methods for concrete*.

A list of all parts in the ISO 23945 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Sprayed concrete is widely used for the stabilization of structures in a very short time and for concrete applications without using moulds. In addition to being ideal for ground support in tunnelling and mining, sprayed concrete is also used in repairs, restoration, new construction and many other fields.

The requirements for properties, test methods, standards and specifications for the spray-forming process of concrete are different from those of cast-forming concrete. This document is intended to provide a normative test method for determining the effect on the setting time of cement paste by flash setting accelerating admixtures for sprayed concrete.

This document is applied under various climatic and geographical conditions, various levels of protection and under different established regional traditions and experiences. Consequently, this document includes conditions for tests covering standard test conditions and tropical and subtropical regional environments.

This document is intended for use with other parts of the ISO 23945 series, which are intended to be developed and which will provide requirements associated with the level of quality specified and the methods to be employed for the execution of sprayed concrete.

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Test methods for sprayed concrete —

Part 1:

Flash setting accelerating admixtures — Setting time

1 Scope

This document specifies the test method, sampling, procedure and determination of cement paste containing a flash setting accelerating admixture for sprayed concrete. Related terms and definitions are also given.

This document does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this document to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 679, *Cement — Test methods — Determination of strength*

ISO 9597, *Cement — Test methods — Determination of setting time and soundness*

ISO 22904, *Additions for concrete*

ISO 22965 (all parts), — *Concrete*

ISO 29581-1, *Cement — Test methods — Part 1: Analysis by wet chemistry*

ISO 29581-2, *Cement — Test methods — Part 2: Chemical analysis by X-ray fluorescence*

EN 196-2, *Method of testing cement — Part 2: Chemical analysis of cement*

EN 196-6, *Methods of testing cement — Part 6: Determination of fineness*

ASTM C187-16:2016, *Standard Test Method for Amount of Water Required for Normal Consistency of Hydraulic Cement Paste*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1

flash setting accelerating admixture

admixture to develop very early setting and very early hardening of sprayed concrete

Note 1 to entry: For more information on admixture, see ISO 19596.

3.2

powdery flash setting accelerating admixture

flash setting accelerating admixture (3.1) used in the form of powder

Note 1 to entry: This is usually fit for the dry spraying process operation.

3.3

liquid flash setting accelerating admixture

flash setting accelerating admixture (3.1) used in the form of liquid

Note 1 to entry: This is usually fit for the wet spraying process operation.

Note 2 to entry: Liquid admixture includes solution type and suspension type.

4 Significance and use

4.1 The performance of a flash setting accelerating admixture for sprayed mortar or concrete varies with the composition of the cement as well as with environmental conditions. Even for a given cement and specified testing conditions, the variation in specimen preparation, test procedure, operation time and test equipment can result in a very different result of the setting time. In this way the test method for the setting time of cement paste containing flash setting accelerating admixtures is quite different from that of ordinary cement paste.

4.2 Since this test method involves the determination of the setting time of a particular combination of a cement and a flash setting accelerating admixture, it therefore provides information on the suitability for use of that particular combination.

4.3 The method described in this document can also be used for the determination of the setting time of the cement paste with additions and flash setting accelerating admixtures for shotcrete.

4.4 The setting time of the combination established in the laboratory does not necessarily indicate that the setting time will produce the same result in an actual shotcreting or at different temperatures from laboratory temperatures.

5 Test environment conditions

The specimen preparation and setting time measurement should be conducted in a closed environment, in which the temperature is maintained in the range of (20 ± 2) °C with relative humidity > 50 %.

For countries in tropical and subtropical climates, alternative environment conditions, with the temperature maintained in the range of (27 ± 2) °C with humidity in the range of (65 ± 5) % can be employed.

All the materials and apparatus should be kept at the same temperature required for the test.

6 Apparatus

6.1 Flat trowel, having a sharpened straight-edged steel blade 100 mm to 150 mm in length. The edges when placed on a plane surface shall not depart from straightness by more than 1 mm.

6.2 Mixer, bowl, paddle and scraper, conforming to the requirements in ISO 679.

6.3 Glass graduates, 200 ml or 250 ml capacity, capable of dispensing to an accuracy of ± 1 ml.

6.4 Mass-determining devices: balance for cement, capable of weighing to an accuracy of ± 1 g; balance for admixture and water, capable of weighing to an accuracy of $\pm 0,5$ g. The devices for determining mass shall be evaluated for precision and accuracy at a total load of 1 000 g.

6.5 Plane non-absorptive plates, 100 mm \times 100 mm square, of similar planeness, corrosivity and absorptivity to that of glass. Plates shall conform to the test method in ASTM C187-16:2016, Figure 1, item H).

6.6 Vicat test apparatus, used for the determination of the setting time and consistency of cement, conforming to the requirements of ISO 9597. The apparatus consists of a metal frame with a sliding rod. An adjustable indicator moves over a graduated scale. The needle or plunger is attached to the bottom end of the rod to make up the test weight of 300 g. The frame is supplied without accessories, which have to be ordered separately depending on the requirement.

6.7 Vicat mould, with a top internal diameter of $(65 \pm 0,5)$ mm, a bottom internal diameter of $(75 \pm 0,5)$ mm, and a depth of $(40 \pm 0,2)$ mm, equipped with a base-plate larger than the mould and at least 2,5 mm thick.

6.8 Medical plastic syringe, 50 ml (for the addition of liquid flash setting accelerating admixture).

6.9 Timer, capable of measuring to an accuracy of ± 1 s.

6.10 Thermometer, with division value of 1 °C.

6.11 Hygrometer, with division value of 1 %.

7 Materials

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7.1 Cement

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Portland cement, conforming to the ISO 22965 series, as specified in ISO 22904, shall be used for testing. Cement should be stored in completely filled and airtight containers made from material that does not react to cement.

The test cement shall be selected by the manufacturer and further characterized by its fineness and contents of tricalcium aluminate and alkalis as follows:

- Fineness (Blaine): at least 300 m²/kg when determined in accordance with EN 196-6 (or equivalent);
- Tricalcium aluminate: 6 % to 12 % when determined in accordance with EN 196-2 (or equivalent);
- Alkalis (Na₂O equivalent): 0,4 % to 1,2 % when determined in accordance with ISO 29581-1 or ISO 29581-2 (or equivalent);
- Cement 28-day strength: 42,5 or higher.

7.2 Water

Distilled or deionized water shall be used for validation testing. For other tests, drinking water may be used. In case of dispute, distilled or deionized water shall be used.

8 Procedures

8.1 Preparation of cement paste

8.1.1 Powdery flash setting accelerating admixture

Weigh 400 g of cement and the amount of flash setting accelerating admixture recommended by the manufacturer for the use of 400 g of cement. Wet the bowl and the blade of the cement paste mixer with a damp cloth, ensuring the surface is wet but that there is no free water, place the cement and admixture into the bowl and pre-mix the dry materials for 10 s at low speed. Then quickly add 140 g of distilled or deionized water and turn on the mixer simultaneously to mix the paste for 5 s at low speed, then switch to high speed to mix for 15 s.

8.1.2 Liquid flash setting accelerating admixture

Weigh 400 g of cement, the amount of liquid flash setting accelerating admixture recommended by the manufacturer for the use of 400 g of cement and mixing water (140 g of water including the water in the liquid flash setting accelerating admixture). Wet the bowl and the blade of the cement paste mixer with a damp cloth, ensuring the surface is wet but that there is no free water, place the cement and mixing water into the bowl and pre-mix the cement paste for 30 s at low speed. Then add pre-weighed liquid flash setting accelerating admixture using a syringe into the bowl and turn on the mixer simultaneously to mix the paste for 5 s at low speed, and then switch to high speed to mix for 15 s.

8.2 Moulding test specimen

Put the ready-mixed cement paste, prepared in accordance with [8.1](#), into the Vicat mould placed on the glass plate and vibrate gently several times to make the paste dense. Then scrape off the redundant paste, making a smooth surface. For the specimen of powdery flash setting accelerating admixture, mould the specimen within 50 s after adding the mixing water to the cement to avoid mixing through the setting time. For the specimen of liquid flash setting accelerating admixture, mould the specimen within 50 s after adding the liquid flash setting accelerating admixture to the cement to avoid mixing through the setting time.

The preparation procedures for cement pastes with powdery and liquid admixtures shall be followed in accordance with the flow charts in [Annex A](#) and [Annex B](#).

8.3 Time of initial setting determination

The determination of the setting time shall begin immediately after moulding and continue every 10 s when approaching the initial setting time. In determining the setting time, lower the needle gently until it is in contact with the surface of the specimen, then release the moving parts quickly and allow the needle to penetrate vertically into the paste specimen. Consider the cement paste to have reached its initial set when the time, at which the distance between the end of the initial Vicat needle and the base-plate is (4 ± 1) mm. Repeat the penetration on the same specimen at convenient spaced positions, not less than 8 mm from the rim of the mould or 5 mm from each other, and at least 10 mm from the last penetration position, at 10 s intervals. Clean the Vicat needle immediately after each penetration.

8.4 Time of final setting determination

Invert the filled mould on its base-plate so that the tests for final set are made on the face of the specimen originally in contact with the base plate. Lower the final Vicat needle gently until it is in contact with the paste. Then release the moving parts quickly and allow the needle to penetrate vertically into the paste. Read the scale when penetration ceases; the paste is considered to have reached the final set when the needle first penetrates 0,5 mm only into the specimen, and the final setting time shall be confirmed by repeating the test in the two different penetration positions.