INTERNATIONAL STANDARD

ISO 1920-14

First edition
2019-11

Testing of concrete —

Part 14: Setting time of concrete mixtures by resistance to penetration

Essais du béton —

Partie 14: Temps de prise des mélanges de béton selon l'essai de résistance à la pénétration

Reference number
ISO 1920-14:2019(E)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

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*.

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.

A list of all parts in the ISO 1920 series can be found on the ISO website.

Testing of concrete —

Part 14: Setting time of concrete mixtures by resistance to penetration

1 Scope

This document covers the method for determining the setting time of concrete with slump greater than zero, by testing mortar sieved from the concrete mixture. The initial setting time and the final setting time are the time intervals required for the mortar sieved from the concrete mixture to reach the specified values of penetration resistance after the initial contact of cement and water.

The method can be used for determining the effect of variables such as temperature, type and content of cement, concrete mix proportions and admixtures, on the time of setting and hardening characteristics of concrete.

This test method is applicable under controlled laboratory conditions, as well as under field conditions.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
initial setting time
time elapsed, after the initial contact of cement and water, till the mortar (sieved from the concrete) acquires a penetration resistance of 3,5 N/mm^2

3.2
final setting time
time elapsed, after the initial contact of cement and water, till the mortar (sieved from the concrete) acquires a penetration resistance of 27,6 N/mm^2

4 Principle

A mortar sample is obtained by sieving a representative sample of fresh concrete. The mortar sample is placed in a container and stored at a specified ambient temperature. The resistance of the mortar to penetration by standard needles is measured at regular time intervals. The time of initial and final setting are determined from a plot of penetration resistance versus elapsed time.

5 Apparatus

5.1 Containers for mortar specimens, rigid, watertight, non-absorptive, free of oil/grease, either cylindrical or rectangular in cross-section, with minimum lateral dimension 150 mm and height at least 150 mm.

The container for the mortar specimens from the concrete mixture shall provide enough mortar surfaces for ten undisturbed readings of penetration resistance in accordance with clear distance requirements specified in Clause 9.

5.2 Penetration resistance apparatus, of spring reaction type, graduated from 50 N to 600 N in increments of 10 N or less, or hydraulic reaction-type apparatus with pressure gauge of 700 N to 900 N capacity, graduated in increments of 10 N or less.

Indications of actual needle loads by these apparatus shall be accurate to 10 N. Removable needles of 645 mm^2, 323 mm^2, 161 mm^2, 65 mm^2, 32 mm^2, and 16 mm^2 bearing areas shall be provided. Each needle shank shall be scribed peripherally at a distance of 25 mm above the bearing face. The length of the 16 mm^2 needle shall be not more than 90 mm to minimize bending. The apparatus shall be recalibrated periodically.

NOTE National specifications can also exist regarding cross-sectional area.

5.3 Pipette, or other suitable instrument for drawing off free water from the surface of the test specimens.

5.4 Tamping rod, round, straight, steel rod 16 mm ± 1 mm in diameter and approximately 600 mm ± 5 mm in length, having the tamping end or both ends rounded to a hemispherical tip, the diameter of which is 16 mm.

NOTE National specifications can also exist regarding the size of the tamping rod.

5.5 Thermometer, capable of measuring the temperature of the fresh mortar to ±0,5 °C.

Glass thermometers having a temperature range from 0 °C to 100 °C are satisfactory. Other thermometers of the required accuracy, including the metal immersion type, are acceptable.

6 Preparation of mortar specimens

6.1 From the concrete mixture under test, select a representative sample of concrete of sufficient volume to provide enough mortar to fill the test container, or containers, to a depth of at least 140 mm. Remove essentially all of the mortar from the sample of concrete by sieving it through a 5 mm (or 4,75 mm) sieve onto a non-absorptive surface.

6.2 Thoroughly mix the mortar manually on the non-absorptive surface. Measure and record the temperature of the mortar. Place the mortar in the container, or containers, using a single layer. Consolidate the mortar to eliminate air pockets in the specimen and level the top surface. This may be accomplished by rocking the container back and forth on a solid surface, and by tapping the sides of the container. Sieved mortar is generally of fluid consistency and air pockets are readily removed by this method of compaction.

For stiffer mortars, alternative methods such as the use of vibrating table or rodding, should be followed. When using vibrating table, use low amplitude vibration so that portions of the sample are not ejected from the container.

If rodding is used, tamp the mortar by the hemispherical end of the tamping rod. Place the mortar in the container(s) in layers of 50 mm each, and compact by tamping each layer. Tamp the mortar once for each 6,5 cm^2 of top surface area of the specimen and distribute the strokes uniformly over the cross-

section of the specimen. After completion of the tamping, tap the sides of the containers lightly with the tamping rod to remove voids left by the tamping rod and to further level the surface of the specimen.

On completion of specimen preparation, the mortar surface shall be at least 13 mm below the top edge of the container to provide space for the collection and removal of bleeding water and to avoid contact between the mortar surface and the protective covering specified in 7.3.

7 Storage of mortar specimens

7.1 For test under laboratory conditions, store the specimens, at a temperature of 20 °C ± 2 °C, (27 °C ± 2 °C for tropical countries), humidity at >65 %, or in accordance with national standards, or as specified by the user.

7.2 For tests under field conditions, store the specimens under ambient conditions, or as specified by the user. Shield the specimens from direct sunlight.

7.3 Measure and record the ambient air temperature at the start and finish of the test. To prevent excessive evaporation of moisture, keep the specimens covered with a suitable material such as a damp burlap or a tight fitting, water impermeable cover, for the duration of the test, except when the bleed water is being removed or penetration tests are being made.

8 Number of specimens

8.1 For tests under field conditions, prepare three specimens from each sample of concrete.

8.2 For tests under laboratory conditions, the requirements depend on the purpose of the tests.

8.2.1 For testing to prove compliance of a material with performance requirements, at least three separate batches shall be made for each test condition. One test shall be made on each batch. An equal number of batches for each condition shall be made on any given day. When it is impossible to make at least one test for each variable on a given day, the mixing of the entire series of batches shall be completed in as few days as possible and one of the mixtures shall be repeated each day as a standard of comparison.

8.2.2 For other tests, prepare three test specimens from one batch of concrete for each test variable.

9 Procedure

9.1 Remove bleed water from the surface of the mortar specimens just before making a penetration test by means of a pipette or a suitable instrument. To facilitate the collection of bleeding water, tilt the specimen carefully to an angle of about 10° from the horizontal by placing a block under one side two minutes before removing the water.

9.2 Insert a needle of appropriate size, depending on the state of hardening of the mortar, in the penetration resistance apparatus and bring the bearing surface of the needle into contact with the mortar surface. Gradually and uniformly apply a vertical force downward on the apparatus until the needle penetrates the mortar to a depth of 25 mm as indicated by the scribe mark. The time required to penetrate to the 25 mm depth shall be approximately 10 seconds. Record the force required and the time of application, measured as elapsed time after initial contact of cement and water. In subsequent penetration tests, take care to avoid areas where the mortar has been disturbed by previous tests. The clear distance between two needle impressions shall be at least two diameters of the needle being used, but not less than 13 mm. The clear distance between any needle impression and the side of the container shall be not less than 25 mm.

9.3 Make penetration tests at hourly intervals for normal mixtures and normal temperatures, the initial test being made after an elapsed time of 2 h to 3 h. For accelerated mixtures or high temperatures, it can be advisable to make the initial test after an elapsed time of 1 h or 2 h and subsequent tests at 30-minute intervals. For low-temperature conditions or retarded concrete mixtures, the initial penetration test may be deferred for an elapsed time of 4 h to 6 h and perhaps longer. Subsequent tests may be made at intervals of 1 h, unless the rate of increase in penetration resistance indicates that shorter intervals are desirable.

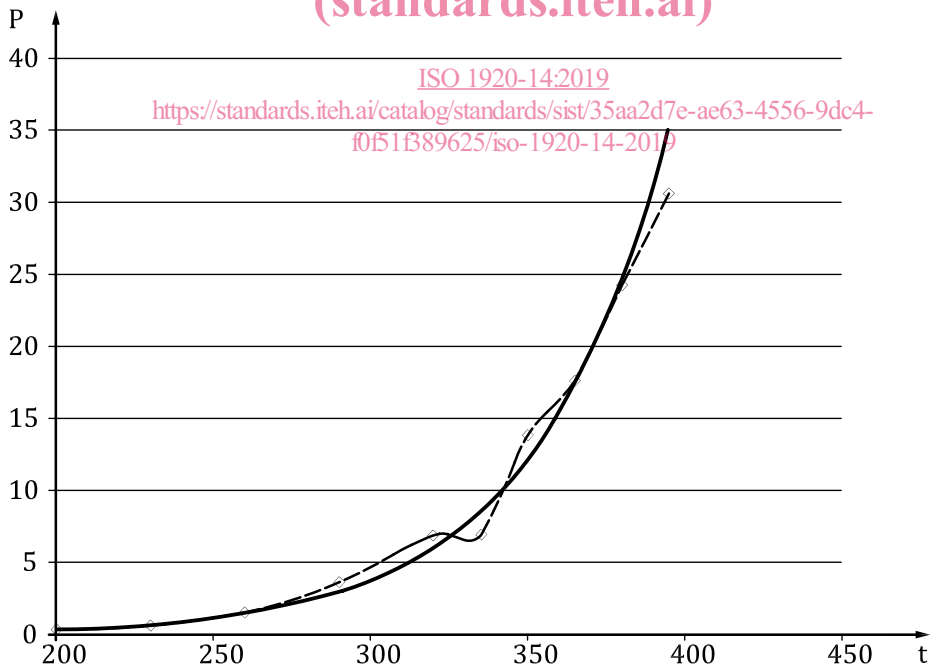
9.4 Not less than six penetrations shall be made in each rate of hardening test and the time intervals between penetration resistance determinations shall be such as to give a satisfactory rate of hardening curve, as indicated by equally spaced points. Continue the tests until one penetration resistance of at least 27,6 N/mm^2 is reached.

Calculate the penetration resistance in N/mm^2**,** as the force required to cause a 25 mm depth of penetration of the needle divided by the area of the bearing face of the needle.

10 Plotting test results and calculation

10.1 Curves: For each variable and condition of concrete as specified in Clause 8, the results from each of three or more rates of hardening tests shall be plotted separately, showing penetration resistance in N/mm^2 as the ordinate or y axis and elapsed time in minutes as the abscissa or X-axis, where 3,5 N/mm^2 and 1 hour are represented by not less than 13 mm.

A typical curve plotting penetration resistance, P in N/mm^2 vs elapsed time, t (in min) based on test observations is shown in Figure 1.



Key

P penetration resistance (N/mm^2)

t elapsed time (min)

Figure 1 — Plot of penetration values versus elapsed time and hand fit curve used to determine time of setting

10.2 Time of setting: Times of initial and final setting as defined in 3.1 and 3.2 shall be calculated by averaging the elapsed times, determined from the curves plotted in accordance with 10.1 at which

penetration resistances of 3,5 N/mm^2 and 27,6 N/mm^2 respectively, are reached. Times of setting shall be reported in hours and minutes to the nearest five minutes.

10.3 A suitable calculator or a computer can be used for calculating the logarithms of the data to determine the times of setting by linear regression analysis. Using a log-log graph paper, prepare a graph of penetration resistance, as the ordinate, versus elapsed time in minutes, as the abscissa. The limit of penetration resistance on the ordinate should extend from 0,1 N/mm^2 to 100 N/mm^2, and the limits of elapsed time on the abscissa should extend from 10 min to 1 000 min. If slow setting mixtures are used, the time limits may need to be 100 min to 10 000 min.

11 Report

The report shall include the following:

a) identification of the test sample;

b) location where the test was performed;

c) date and time of test;

d) ambient temperature;

e) data on concrete mix — grade, mix proportions, and maximum nominal size of aggregates;

f) air content of fresh concrete and method of determination, if specified;

g) consistency of concrete as determined by the slump or other test for consistency;

h) the initial and final setting time as observed, in hours and minutes, to the nearest minute;

i) any deviation from the standard test method;

j) declaration by the person technically responsible for the test that it was carried out in accordance with this document, except as noted in item i).

In addition, the report may include the temperature of mortar after sieving.