

**EUROPEAN STANDARD**  
**NORME EUROPÉENNE**  
**EUROPAISCHE NORM**

**EN 196**

Part 3

May 1987

UDC 666.94-691.54:620.1:543.7

Key words : Cements, Tests, Determination, Setting time, Consistency, Stability.

English version

**Methods of testing cement;**  
**Determination of setting time and soundness**

Méthodes d'essais des ciments;  
Détermination du temps de prise  
et de la stabilité

Prüfverfahren für Zement;  
Bestimmung der Erstarrungs-  
zeiten und der Raumbe-  
ständigkeit

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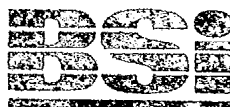
**CEN**

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Comité Européen de Normalisation  
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### BRIEF HISTORY

This European Standard was drawn up by the Technical Committee CEN/TC 51 "Cement" the Secretariat of which is held by IBN.

According to the Common CEN/CENELEC Rules, following countries are bound to implement this European Standard:

Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Sweden.

**FOREWORD**

The standard EN 196 on methods of testing cement consists of the following Parts:

- Part 1: Determination of strength
- Part 2: Chemical analysis of cement
- Part 3: Determination of setting time and soundness
- Part 4: Quantitative determination of constituents
- Part 5: Pozzolanicity test for pozzolanic cements
- Part 6: Determination of fineness
- Part 7: Methods of taking and preparing samples of cement

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## 1 OBJECT AND FIELD OF APPLICATION

This European Standard describes the methods for determining setting time and soundness of cements.

It is applicable to all cements covered by EN 197-1.

This standard describes the reference procedure; it allows the use of alternative procedures as indicated in notes provided that they do not affect the results significantly. In the event of a dispute, only the reference procedure described in this standard shall be used, excluding any alternatives.

## 2 REFERENCES

EN 196-1 Methods of testing cement

Part 1. Determination of strength

EN 197-1 Definitions and specifications for cements

Part 1. Definitions and terminology<sup>1)</sup>

## 3 TEST PRINCIPLES

The setting time is determined by observing the penetration of a needle into cement paste of standard consistence until it reaches a specified value.

The soundness is determined by observing the volume expansion of cement paste of standard consistence as indicated by the relative movement of two needles.

Cement paste of standard consistence has a specified resistance to penetration by a standard plunger. The water required for such a paste is determined by trial penetrations of pastes with different water contents.

## 4 GENERAL REQUIREMENTS FOR TESTING

### 4.1 Laboratory

The laboratory in which specimens are prepared and tested shall be maintained at a temperature of  $20 \pm 2$  °C and a relative humidity of not less than 65 %.

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1) At present at the draft stage.

## 4.2 Apparatus

4.2.1 Balance, capable of weighing to the nearest 1 g.

4.2.2 Graduated cylinder or burette, capable of measuring to the nearest 1 % of the volume measured.

4.2.3 Mixer, complying with 4.4 of EN 196-1.

## 4.3 Materials

4.3.1 Distilled or deionized water shall be used for making, storing and boiling specimens.

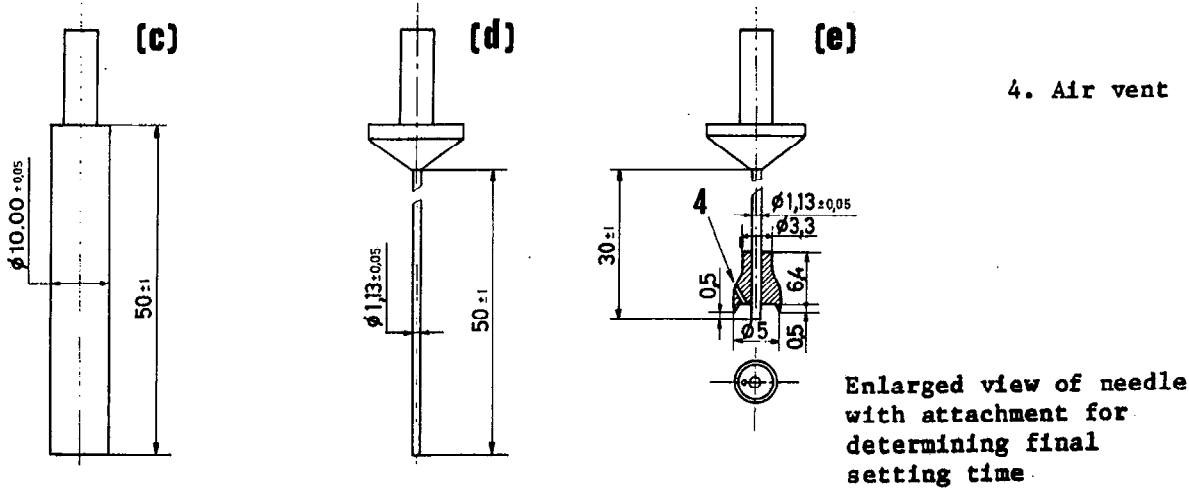
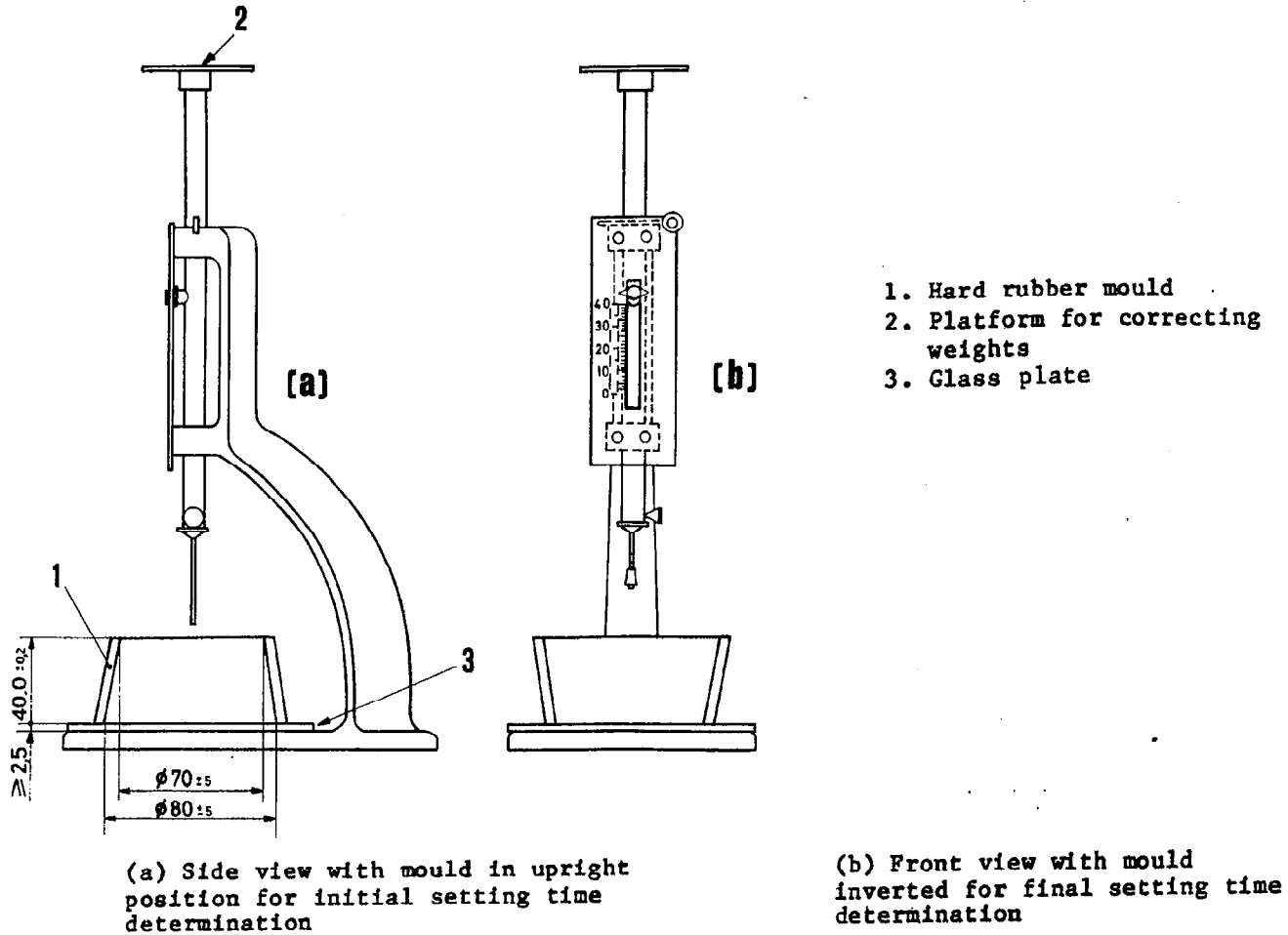
NOTE - Other water may be used provided that it can be shown to give the same test results.

4.3.2 Cement, water and apparatus used to make and test specimens shall be at a temperature of  $20 \pm 2$  °C.

## 5 STANDARD CONSISTENCE TEST

### 5.1 Apparatus

Use the Vicat apparatus as shown in figure 1(a) and 1(b) with the plunger shown in figure 1(c). The plunger (figure 1(c)) shall be of non-corrodible metal in the form of a right cylinder of  $50 \pm 1$  mm effective length and of  $10,00 \pm 0,05$  mm diameter. The total mass of moving parts shall be  $300 \pm 1$  g. Their movement shall be truly vertical and without appreciable friction, and their axis shall coincide with that of the plunger.



(c) Plunger for standard consistence

(d) Needle for initial set

(e) Needle and attachment for final set

Dimensions in millimetres

NOTE. The specified dimensions have to be observed. If the plunger, needle and needle with attachment are all adjusted to have the same mass e.g.  $9 \pm 0,5$  g, one correcting weight is sufficient for each apparatus.

FIGURE 1 - Vicat apparatus for determining the standard consistence and setting time of cement

The Vicat mould (see Figure 1(a)) to contain the paste under test shall be of hard rubber. It shall be of truncated conical form  $40,0 \pm 0,2$  mm deep and shall have internal diameters at top and bottom of  $70 \pm 5$  mm and  $80 \pm 5$  mm respectively. It shall be adequately rigid and shall be provided with a plane glass base-plate larger than the mould and at least 2,5 mm thick.

NOTE - Moulds of metal or plastics or of cylindrical form may be used provided that they are of the specified depth and that they can be shown to give the same test results as the specified hard rubber mould of truncated conical form.

## 5.2 Procedure

5.2.1 Mixing the cement paste. Weigh, to the nearest 1 g, 500 g of cement. Weigh a quantity of water, e.g. 125 g, in the mixer bowl or measure the water from the graduated cylinder or burette into the mixer bowl.

Add the cement carefully to the water in order to avoid loss of water or cement. The time of addition shall be not less than 5 s nor more than 10 s. Note the time of completion of the addition as zero time from which later measurements of time shall be made. Start the mixer immediately and run at low speed for 90 s.

Stop the machine after 90 s for 15 s during which remove with a suitable scraper any paste adhering to the bowl outside the mixing zone and return it to the mix. Restart the machine and run at low speed for a further 90 s. The total mixer running time shall be 3 min.

NOTE - Any other mixing method, whether by machine or hand, may be used provided that it can be shown to give the same test results as the specified method.

5.2.2 Filling the mould. Transfer the paste immediately to the mould, which has previously been placed on a lightly greased plane glass base-plate, and fill it to excess without undue compaction or vibration. Remove the excess by a gentle sawing motion with a straight-edged implement in such a way as to leave the paste filling the mould and having a smooth upper surface.

5.2.3 Penetration test. Calibrate the Vicat apparatus with the plunger (figure 1(c)), attached in advance of the test, by lowering the plunger to rest on the base-plate to be used and adjusting the pointer to read zero on the scale. Raise the plunger to the stand-by position.

Immediately after levelling the paste, transfer the mould and base-plate to the Vicat apparatus and position it centrally under the plunger. Lower the plunger gently until it is in contact with the paste. Pause in that position for between 1 s and 2 s in order to avoid initial velocity or forced acceleration of the moving parts. Then release the moving parts quickly and allow the plunger to penetrate vertically into the centre of the paste. The release of the plunger shall occur 4 min after zero time. Read the scale when penetration has ceased or 30 s after the release of the plunger, whichever is the earlier.

Record the scale reading, which indicates the distance between the bottom face of the plunger and the base-plate, together with the water content of the paste expressed as a percentage by mass of the cement. Clean the plunger immediately after each penetration.

Repeat the test with pastes containing different water contents until one is found to produce a distance between plunger and base-plate of  $6 \pm 1$  mm. Record the water content of that paste to the nearest 0,5 % as the water for standard consistence.

## 6 SETTING TIME TEST

### 6.1 Apparatus

6.1.1 A room or a humidity cabinet of adequate size and maintained at  $20 \pm 1$  °C and not less than 90 % relative humidity.

NOTE - Provided that it can be shown to give the same test results, a water-bath capable of maintaining filled moulds above water at  $20 \pm 1$  °C may be used.

6.1.2 Vicat apparatus for initial set. Remove the plunger and replace it by the needle (figure 1(d)) which shall be of steel and in the form of a right cylinder of effective length  $50 \pm 1$  mm and diameter  $1,13 \pm 0,05$  mm. The total mass of moving parts shall be  $300 \pm 1$  g. Their movement shall be truly vertical and without appreciable friction, and their axis shall coincide with that of the needle.

### 6.2 Determination of initial setting time

Calibrate the Vicat apparatus with the needle (figure 1(d)), attached in advance of the test, by lowering the needle to rest on the base-plate to be used and adjusting the pointer to read zero on the scale. Raise the needle to the stand-by position.

Fill a Vicat mould with paste of standard consistence and level it, in accordance with 5.2.1 and 5.2.2.

Place the filled mould and base-plate in the room or humidity cabinet specified in 6.1.1 and, after a suitable time, transfer to the Vicat apparatus and position under the needle. Lower the needle gently until it is in contact with the paste. Pause in that position for between 1 s and 2 s in order to avoid initial velocity or forced acceleration of the moving parts. Then release the moving parts quickly and allow the needle to penetrate vertically into the paste. Read the scale when penetration has ceased, or 30 s after the release of the needle, whichever is the earlier.



Record the scale reading, which indicates the distance between the end of the needle and the base-plate, together with the time from zero. Repeat the penetration test on the same specimen at conveniently spaced positions, not less than 10 mm from the rim of the mould or from each other, at conveniently spaced intervals of time, e.g. at 10 min intervals. Between penetration tests keep the specimen in a room or humidity cabinet as specified in 6.1.1. Clean the Vicat needle immediately after each penetration. Record the time measured from zero at which the distance between the needle and the base-plate is  $4 \pm 1$  mm as the initial setting time of the cement to the nearest 5 min. The required accuracy may be assured by reducing the time interval between penetration tests near the end-point and observing that successive results do not fluctuate excessively.

### 6.3 Determination of final setting time

Invert the filled mould used in 6.2 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. Fit the needle with a ring attachment (figure 1(e)) to facilitate accurate observation of small penetrations. Use the procedure described in 6.2. The intervals of time between penetration tests may be increased to e.g. 30 min.

Record, to the nearest 15 min, the time measured from zero at which the needle first penetrates only 0,5 mm into the specimen as the final setting time of the cement. This time is that at which the ring attachment first fails to mark the specimen and may be accurately established by reducing the time interval between tests near the end-point and observing that successive test results do not fluctuate excessively.

NOTE - Automatic setting time machines are commercially available and may be used provided that they can be shown to give the same test results as the specified apparatus and procedure.

## 7 SOUNDNESS TEST

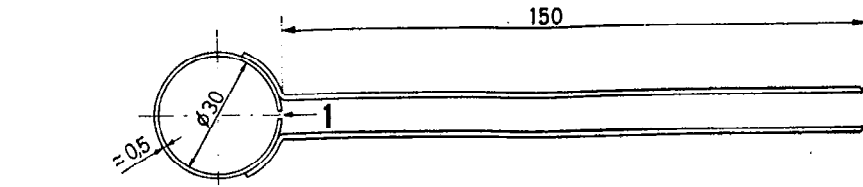
### 7.1 Apparatus

7.1.1 Le Chatelier apparatus. The mould shall be of spring brass with indicator needles and shall have the dimensions shown in figure 2(a). The resilience of the mould shall be such that the action of a mass of 300 g applied as shown in figure 2(c) shall increase the distance between the indicator ends of the needles by  $17,5 \pm 2,5$  mm without permanent deformation.

A pair of plane glass base and cover plates shall be provided for each mould. Each plate shall be larger than the mould. The cover plate shall weigh at least 75 g; an additional small mass may be placed on a thin plate to satisfy this requirement.

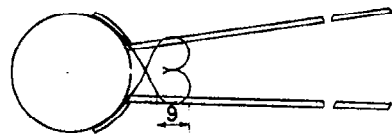
7.1.2 Water-bath with means of heating, capable of containing immersed Le Chatelier specimens and of raising the temperature of the water from  $20 \pm 2$  °C to boiling in  $30 \pm 5$  min.

7.1.3 Humidity cabinet, of adequate size and maintained at  $20 \pm 1$  °C and not less than 98 % relative humidity.

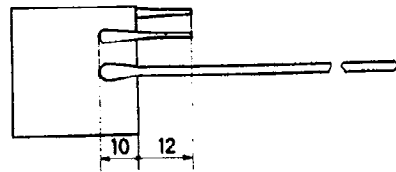


(a)

- 1. Split
- 2. Glass plate

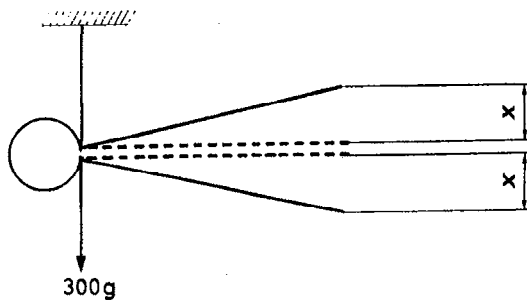


(b)



(b) Arrangement of loops for demoulding

NOTE. Provision of the two loops shown soldered to the upper half of the mould, on each side of the central split, facilitates demoulding of the hardened paste specimen after test.



Increase in separation of indicator ends (c)  
 $2x = 17,5 \text{ mm} \pm 2,5 \text{ mm}$

(c) Resilience test arrangement

FIGURE 2 - Le Chatelier apparatus for the determination of soundness of cements

## 7.2 Procedure

Carry out the test simultaneously on two specimens from the same batch of cement paste.

Prepare a cement paste of standard consistence. Place a lightly oiled Le Chatelier mould on the lightly oiled base-plate and fill it immediately without undue compaction or vibration using only the hands and a straight-edged implement, if desired, to level the top surface. During filling, prevent the slit in the mould from accidentally opening e.g. by gentle pressure with the fingers or by tying or by use of a suitable rubber band.

Cover the mould with the lightly oiled cover plate, add the additional mass, if necessary, and then immediately place the complete apparatus in the humidity cabinet. Maintain it for  $24 \pm 0,5$  h at  $20 \pm 1$  °C and not less than 98 % relative humidity.

NOTE - Provided that it can be shown to give the same test results, the mould may be placed, between its glass plates, with the additional mass, if necessary, in a water-bath and maintained under water for  $24 \pm 0,5$  h at  $20 \pm 1$  °C.

At the end of the  $24 \pm 0,5$  h period measure the distance (A) between the indicator points to the nearest 0,5 mm. Then heat the mould gradually to boiling during  $30 \pm 5$  min and maintain the water-bath at boiling temperature for  $3 \text{ h} \pm 5$  min.

NOTE - Where it can be shown that the expansion after a shorter boiling period is the same as that after 3 h, such a shorter period may be used.

At the end of the boiling period the distance (B) between the indicator points may be measured to the nearest 0,5 mm.

Allow the mould to cool to  $20 \pm 2$  °C. Measure the distance (C) between the indicator points to the nearest 0,5 mm.

For each specimen, record the measurements A and C and calculate the difference  $C - A$ . Calculate the mean of the two values of  $C - A$  to the nearest 0,5 mm.

## 7.3 Interpretation

The main purpose of the soundness test is to assess the possible risk of late expansion due to hydration of uncombined calcium oxide and/or magnesium oxide. For this purpose report the mean difference  $C - A$ .

NOTE - Where it can be shown that the conditions of the test lead to no significant difference between measurements B and C, the difference  $B - A$  may be reported since this reduces the time needed for the test.

#### 7.4 Retest

Should the fresh cement fail to comply with the specified soundness requirement it may be retested after storage. For this purpose, spread out the cement in a layer of 7 cm thickness and store it for 7 days in an atmosphere maintained at  $20 \pm 2$  °C and not less than 65 % relative humidity. Then retest the cement according to 7.2.