

ASTM C191

Standard Test Method for Time of Setting of Hydraulic
Cement by Vicat Needle

**Understanding ASTM International Test Procedures
for Cement and Concrete - Staying Up to Standard**

Anthony F. Bentivegna, Ph.D., P.E.

May 9, 2016



Outline

- ▶ Objectives
- ▶ Related Procedures
- ▶ Scope/Summary Test Method/Significance and Use
- ▶ Apparatus
- ▶ Procedure Manual Vicat
- ▶ Procedure Automatic Vicat
- ▶ Calculation
- ▶ Understand Limitations of Procedure



Objectives

- ▶ Define Key Terminology
- ▶ Identify Necessary Equipment
- ▶ Understand Sources of Errors
- ▶ Understand Limitations of Procedure

www.CTLGroup.com



Related Procedures

- ▶ ASTM C150 – Specification for Portland Cement
- ▶ ASTM C151 – Test Method for Autoclave Expansion of Hydraulic Cement
- ▶ ASTM C183 – Practice for Sampling and the Amount of Testing of Hydraulic Cement
- ▶ ASTM C187 – Test Method for Amount of Water Required for Normal Consistency of Hydraulic Cement Paste
- ▶ ASTM C219 – Terminology Relating to Hydraulic Cement
- ▶ ASTM C266 – Test Method for Time of Setting of Hydraulic-Cement Paste by Gillmore Needles

www.CTLGroup.com



Related Procedures

- ▶ ASTM C305 – Practice for Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency
- ▶ ASTM C511 – Specification for Mixing Rooms, Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes
- ▶ ASTM C595 – Specification for Blended Hydraulic Cements
- ▶ ASTM C1005 – Specification for Reference Masses and Devices for Determining Mass and Volume for Use in the Physical Testing of Hydraulic Cements
- ▶ ASTM C1157 – Performance Specification for Hydraulic Cements
- ▶ ASTM D1193 – Specification for Reagent Water

www.CTLGroup.com



Scope

- ▶ These test methods determine the **time of setting** of hydraulic cement by means of the Vicat needle. Two test methods are given;
 - **Method A** is the Reference Test Method using the **manually** operated standard Vicat apparatus, while
 - **Method B** permits the use of an **automatic** Vicat machine that has, in accordance with the qualification requirements of this method, demonstrated acceptable performance.

www.CTLGroup.com



Summary of Test Method

- ▶ A paste that is proportioned and mixes to **normal consistency** is molded and placed in a moist cabinet and allowed to start setting
- ▶ Periodic **penetration tests** are performed on this paste by allowing a 1-mm Vicat needle to settle into the past

www.CTLGroup.com



Summary of Test Method

- ▶ **Initial time of set** is the time elapsed between the initial contact of cement and water and the time when the penetration is measured to be **25 mm**
- ▶ **Final time of set** is the time elapsed between the initial contact of cement and water and the time when the needle does not leave a complete circular impression in the paste surface

www.CTLGroup.com



Significance and Use

- ▶ This test method provides a means of determining compliance with a specification limit for **Vicat time of setting**.
- ▶ Time of setting measured by this method *will not necessarily provide the same results* as the time of setting by other methods.

www.CTLGroup.com



Apparatus

- ▶ Vicat Apparatus
- ▶ Scale: accuracy up to a total load of 1000 g
- ▶ Glass graduates: 200 or 250 mL capacity
- ▶ Plane non-adsorptive plate: 100 ± 5 mm square
- ▶ Flat Trowel: with blade 100 to 150 mm in length
- ▶ Conical Ring: rigid, non-corroding, non-absorbent
- ▶ Mixer, bowl, and paddle
- ▶ Specimen Mold

www.CTLGroup.com



Apparatus: Vicat



Manual Vicat



Automatic Vicat

www.CTLGroup.com



Reagents and Materials

- ▶ **Mixing water**
 - Potable water is satisfactory for routine tests
 - For referee and cooperative tests use water conforming to ASTM D1193 for Type III or Type IV grade reagent water

www.CTLGroup.com



Conditioning

- ▶ Maintain the **temperature of the air** in the vicinity at $23.0 \pm 3.0^{\circ}\text{C}$
- ▶ Maintain the **temperature of the mixing water** at $23.0 \pm 2.0^{\circ}\text{C}$
- ▶ The relative humidity of the mixing room shall not be less than 50%
- ▶ The moist cabinet shall be in accordance with ASTM C511

www.CTLGroup.com



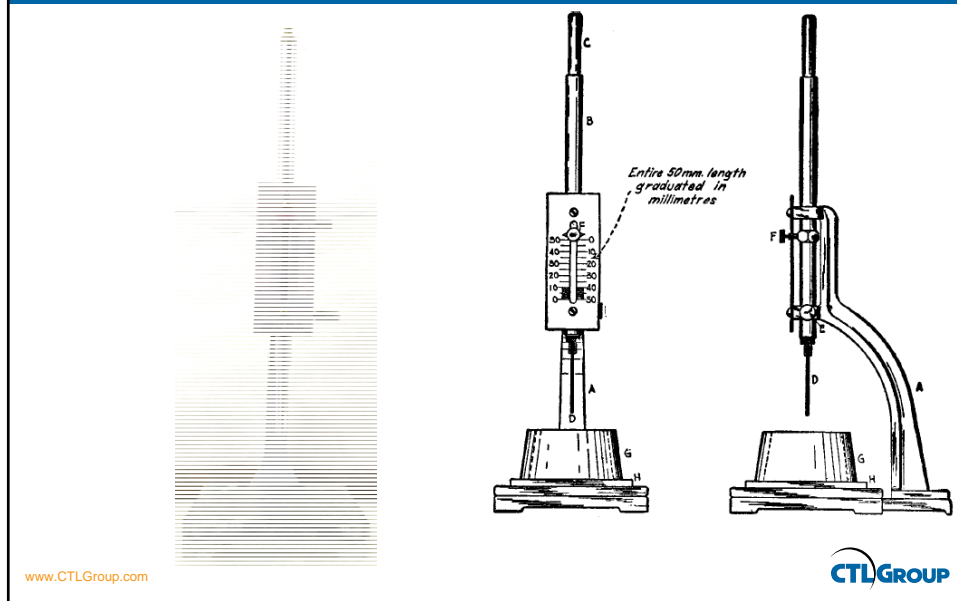
Preparation of Cement Paste

- ▶ Can prepare a new batch of paste by mixing 650 g of cement with the proper percentage of water required for normal consistency (ASTM C187)
 - Can use the specimen used for determining normal consistency for Method A only

www.CTLGroup.com

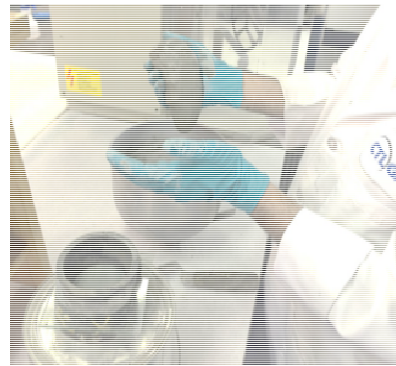


Method A – Manual Vicat Needle Apparatus



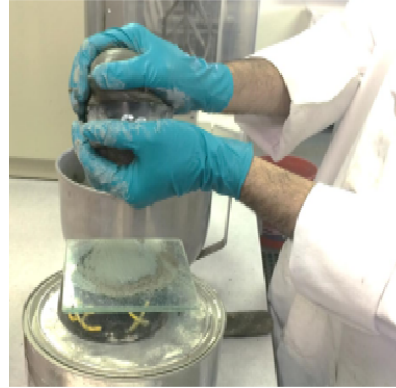
Method A – Manual Vicat Needle Apparatus

- ▶ Molding the test specimen
 - Quickly form the cement paste into a ball and **toss six times from one hand to the other** maintaining hands about 150 mm apart



Method A – Manual Vicat Needle Apparatus

- ▶ Molding the test specimen
 - Press the ball into the larger end of the conical ring, completely filling the ring with paste



www.CTLGroup.com

CTLGROUP

Method A – Manual Vicat Needle Apparatus

- ▶ Molding the test specimen
 - Remove the excess at the larger end by a single movement of the palm



www.CTLGroup.com

CTLGROUP

Method A – Manual Vicat Needle Apparatus

- ▶ Molding the test specimen
 - Place the ring on its larger end onto the non-absorptive plate



www.CTLGroup.com

CTLGROUP

Method A – Manual Vicat Needle Apparatus

- ▶ Molding the test specimen
 - Slice off the excess paste at the smaller end of at the top of the ring by a single stroke of the trowel



www.CTLGroup.com

CTLGROUP

Method A – Manual Vicat Needle Apparatus

- ▶ Molding the test specimen
 - Smooth the top of the specimen with one or two light touches of the pointed end of the trowel
 - During the operation of cutting and smoothing take care not to compress the paste



www.CTLGroup.com

CTLGROUP

Method A – Manual Vicat Needle Apparatus

- ▶ Immediately after molding, place the test specimen in the moist cabinet or moist room
- ▶ Keep it there except when penetration measurements are being made
- ▶ The test specimen will remain in the conical mold and supported by the non-absorptive plate throughout the testing

www.CTLGroup.com

CTLGROUP

Method A – Manual Vicat Needle Apparatus

- ▶ Time of setting determination
 - Determine the penetration of the 1-mm needle after 30 minutes,
 - and every 15 minutes thereafter until a penetration of 25 mm or less is obtained
 - Every 10 minutes for Type III cements

www.CTLGroup.com

CTLGROUP

Method A – Manual Vicat Needle Apparatus

- ▶ A: frame
- ▶ B: movable rod
- ▶ C: plunger end of rod
- ▶ D: removable steel needle
- ▶ E: set screw
- ▶ F: adjustable indicator
- ▶ G: conical ring
- ▶ H: non-absorptive plate

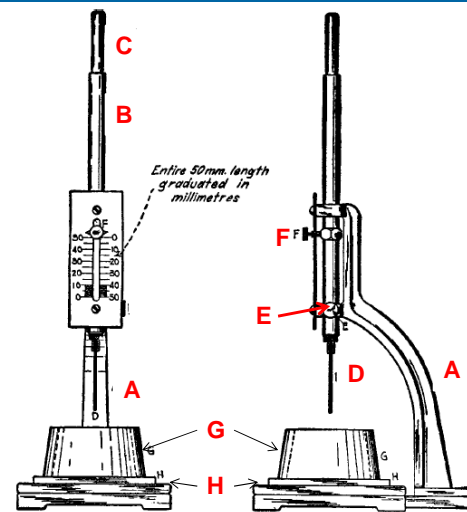


FIG. A1.1 Vicat Apparatus

www.CTLGroup.com

CTLGROUP

Method A – Manual Vicat Needle Apparatus

- ▶ Penetration Test
 - Lower needle D of the rod B until it rests on the cement paste

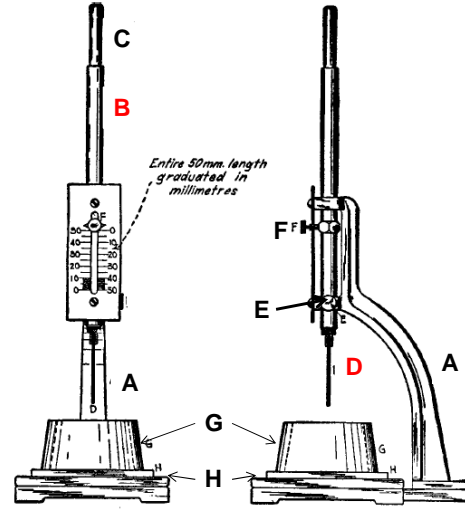


FIG. A1.1 Vicat Apparatus

www.CTLGroup.com

CTLGROUP

Method A – Manual Vicat Needle Apparatus

- ▶ Penetration Test
 - Tighten the setscrew E and set the indicator F at the upper end of the scale
 - Or take an initial reading

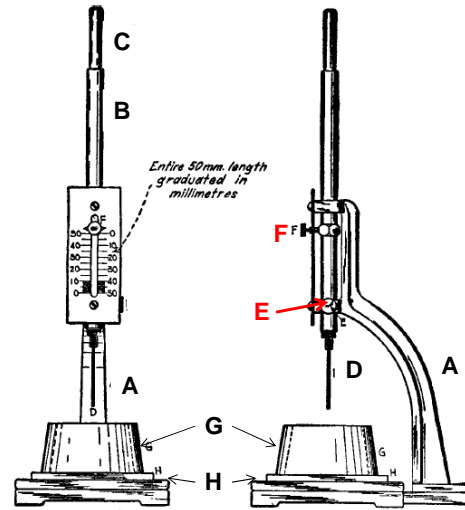


FIG. A1.1 Vicat Apparatus

www.CTLGroup.com

CTLGROUP

Method A – Manual Vicat Needle Apparatus

► Penetration Test

- Release the rod quickly by releasing the setscrew E
- Allow the needle to settle for 30 seconds
- Take a reading to determine penetration

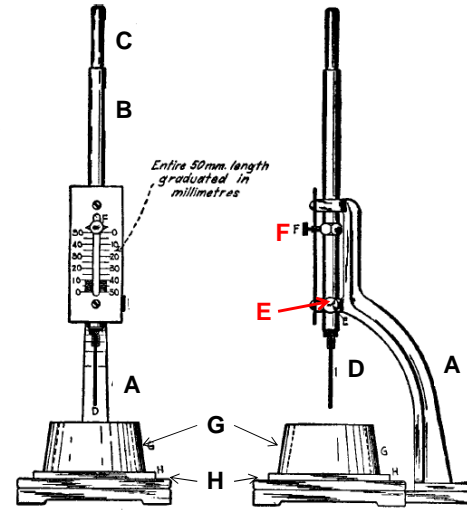


FIG. A1.1 Vicat Apparatus

www.CTLGroup.com

CTLGROUP

Method A – Manual Vicat Needle Apparatus

► Time of setting determination

- Make each penetration test at least 5 mm away from any previous penetrations and at least 10 mm away from the inner side of the mold

www.CTLGroup.com

CTLGROUP

Method A – Manual Vicat Needle Apparatus

- ▶ Time of setting determination
 - Record the results of all penetration tests and by interpolation determine the time when a penetration of 25 mm is obtained.
 - The elapsed time between the initial contact of cement and water and the penetration of 25 mm is the Vicat time of setting or Vicat initial time of setting

www.CTLGroup.com



Method A – Manual Vicat Needle Apparatus

- ▶ Final time of setting determination
 - The end point to be the first penetration measurement that does not mark the specimen surface with a complete circular impression
 - Verify the final set by performing two additional penetration measurements on different areas within 90 seconds of the first recorded final set
 - The elapsed time between the initial contact of cement and water and end point determination is the Vicat final time of setting

www.CTLGroup.com



Method A – Manual Vicat Needle Apparatus

► Precautions

- Keep all the apparatus free from vibration during testing
- Keep the 1-mm needle straight and clean
 - To prevent cement from adhering to the sides of the needle and decreasing penetration
 - To prevent cement from adhering to the point and increasing penetration

www.CTLGroup.com



Method B – Automatic Vicat



www.CTLGroup.com

