EXPERIMENT NO.- 5

a) Standard Test Methods for Time of Setting of Hydraulic Cement by Vicat Needle. - **ASTM C191**

b) Standard Test Method for Density of Hydraulic Cement – **ASTM C188**

5 (a) Standard Test Methods for Time of Setting of Hydraulic Cement by Vicat Needle. - **ASTM C191**

INTRODUCTION

- Cement, when mixed with water, forms slurry which gradually becomes less plastic with the passage of time and finally a hard mass is obtained.
- In This process, a stage is reached when the cement paste is sufficiently rigid to withstand a definite amount of pressure.
- Cement, at this stage is said to have set and the time required to reach this stage is termed **Setting Time**.

INTRODUCTION CONT'D

- The term **Initial Setting Time** indicates the beginning of the setting process of cement paste when cement paste starts losing its plasticity.
- The **Final Setting Time** is the time elapsed between the moment the water is added to cement and time when the paste completely lost its plasticity and attained sufficient stability to resist certain definite pressure.
- As per ASTM C150, Ordinary Portland Cement (OPC) should have the initial setting time not less than 45 minutes and final setting time not more than 375 minutes.

MECHANICAL AND PHYSICAL REQUIREMENTS

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Table 2 — Mechanical and physical requirements given as characteristic values

Strength class	Compressive strength MPa				Initial setting time	Sound-ness (expan-sion)
	Early strength		Standard strength			
	2 days	7 days	28 days		min	mm
32,5 N	–	≥ 16,0	≥ 32,5	≤ 52,5	≥ 75	≤ 10
32,5 R	≥ 10,0	–				
42,5 N	≥ 10,0	–	≥ 42,5	≤ 62,5	≥ 60	
42,5 R	≥ 20,0	–				
52,5 N	≥ 20,0	–	≥ 52,5	–	≥ 45	
52,5 R	≥ 30,0	–				

APPARATUS

- Same as for the **Determination of Normal Consistency of Cement** (See Experiment 04a).

CONDITIONING

- The temperature of the air in vicinity of the mixing slab, the dry cement, molds, and base plates shall be maintained 23 ± 3°C.
- The temperature of the mixing water shall not vary from 23°C by more than ±2°C.
- The relative humidity of the laboratory shall be not less than 50%.

PROCEDURE

Preparation of Cement Paste

- Mix 650 gm of cement with the percentage of mixing water required for normal consistency following the procedure describe in experiment 04.

Molding Test Specimen

- Allow the time of setting specimen to remain in the moist cabinet for 30 min after molding without being disturbed.

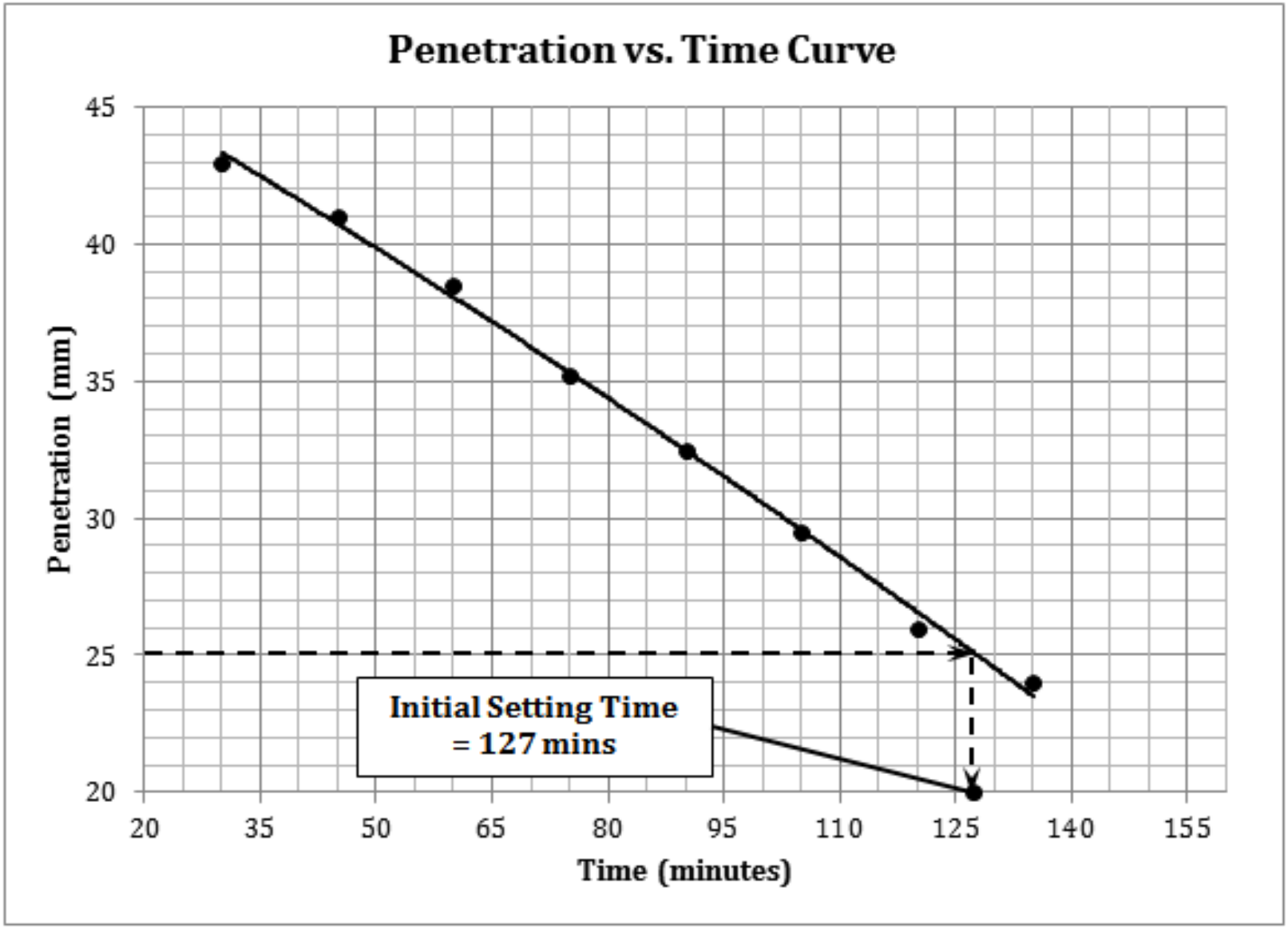
- Determine the penetration of the 1-mm needle at this time and every 15 min thereafter for Ordinary Portland Cement (Type I and every 10 min for Rapid Hardening Cement, Type III) until a penetration of 25 mm or less is obtained.

PROCEDURE CONT'D

- For the penetration test, lower the needle **D** of the rod **B** until it rests on the surface of the cement paste.
- Tighten the set screw, **E**, and set the indicator, **F**, at the upper end of the scale, or take an initial reading.
- Release the rod quickly by releasing the set screw, **E**, and allow the needle to settle for 30 sec; then take the reading to determine the penetration.
- No penetration test shall be made closer than 6.4 mm from any previous penetration and no penetration test shall be made closer than 9.5 mm from the inside of the mold.
- Record the results of the all penetration tests and, by interpolation or by plotting penetration vs. setting time curve, determine the time when a penetration of 25 mm is obtained.
- This is the Initial Setting Time. The Final Setting Time is when the needle does not sink visible in to the paste.

PROCEDURE CONT'D

SAMPLE GRAPH



PRECAUTIONS

- All the apparatus shall be free from vibration during the penetration test.
- Take care to 10 mm needle straight, and needle must be kept clean as the collection of cement on the side of the needle may retard the penetration, while cement on the point (tip) may increase the penetration.
- The time of setting affected not only by the percentage and the temperature of the water used and or kneading the paste received, but also by the temperature and humidity of the air and its determination is therefore only approximate.

SAMPLE DATA SHEET

Data Sheet

Time (minutes)	Penetration (mm)

RESULT

Initial Setting Time = minutes

Final Setting Time = minutes

CALCULATION

- Calculate the time required for 25 mm penetration from a plot of penetration (in mm) against time (in min) in plain graph paper. This time is arbitrarily defined as the **Initial Setting Time**.

QUESTIONS?

- Does this cement Satisfy ASTM standard requirements for *Initial Setting Time*?
- What is the significance of *Setting Time*?
- Distinguish between *Hardening* and *Setting*.
- What is *Quick Setting Cement*?
- How does the *Fineness* affect the time of setting?
- What is the function of a *Retarder*?
- Describe the factors affecting the *Initial Setting Time* of cement.

REPORT

The Report shall include the following information:

- Type of Cement (e.g. OPC, CEM I)
- Brand name of Cement
- Report initial and final setting times in **minutes** after adding water to the cement

5 (b) Standard Test Method for Density of Hydraulic Cement. - **ASTM C188**

INTRODUCTION

- This test method covers the determination of the density of hydraulic cement. Its particular usefulness is in connection with the design and control of concrete mixtures.
- The density of hydraulic cement is defined as the mass of a unit volume of the solids.

APPARATUS

1. Le Chatelier flask

The neck shall be graduated from 0 to 1 mL and from 18 to 24 mL in 0.1-mL graduations. The error of any indicated capacity shall not be greater than 0.05 mL

2. Kerosine

Free of water, or naphtha, having a density greater than **0.73 g/mL** at 23 ± 2° C shall be used in the density determination.

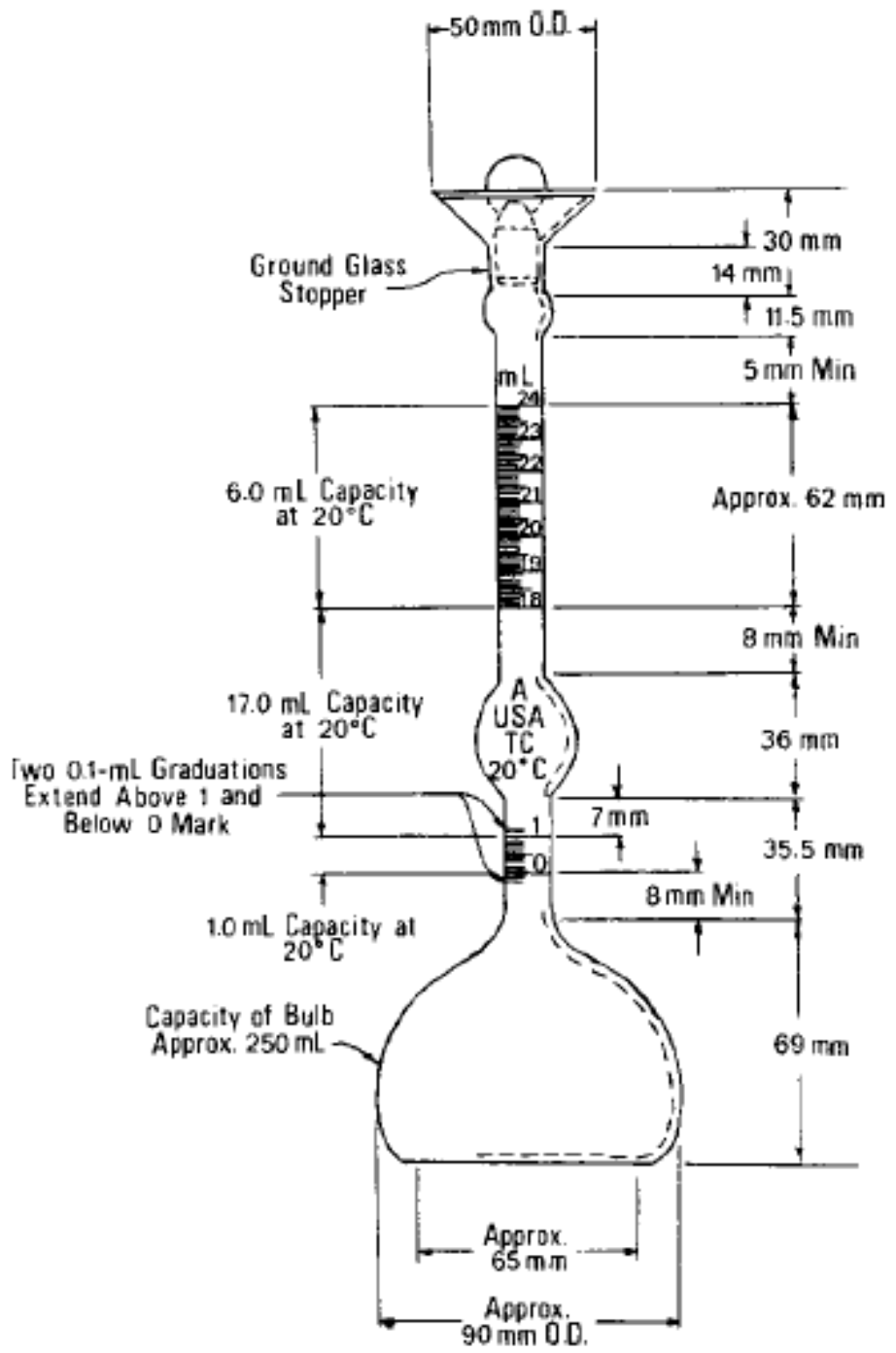


Figure:

Le Chatelier flask

PROCEDURE

- Determine the density of cement on the material as received, unless otherwise specified. If the density determination on a loss-free sample is required, first ignite the sample as described in the test for loss on ignition
- Fill the flask with kerosine to a point on the stem between the 0 and the 1-mL mark.
- Dry the inside of the flask above the level of the liquid, if necessary, after pouring. Record the first reading after the flask has been immersed

PROCEDURE CONT'D

- Introduce a quantity of cement, weighed to the nearest 0.05 g, (about **64 g** for portland cement) in small increments. Take care to avoid splashing and see that the cement does not adhere to the inside of the flask above the liquid.
- After all the cement has been introduced, place the stopper in the flask and roll the flask in an inclined position, or gently whirl it in a horizontal circle, so as to free entrapped air from the cement until no further air bubbles rise to the surface of the liquid.

PROCEDURE CONT'D

- If a proper amount of cement has been added, the level of the liquid will be in its final position at some point of the upper series of graduations. Take the final reading after the flask has been immersed in the water bath.
- Immerse the flask in a constant-temperature water bath for sufficient periods of time in order to avoid flask temperature variations greater than 0.2°C between the initial and the final readings.

CALCULATION

The difference between the first and the final readings represents the volume of liquid displaced by the mass of cement used in the test.

- Calculate the cement density, ρ, as follows:

ρ (g/cm^3) = mass of cement, g/displaced volume, cm^3

REPORT

The Report shall include the following information:

- Type of Cement (e.g. OPC, CEM I)
- Brand name of Cement
- Report density of cement sample ρ in g/cm^3