CONCRETE TECHNOLOGY LABORATORY

DEPARTMENT OF CIVIL ENGINEERING
CHULALONGKORN UNIVERSITY

Tested by ..... ID No. .....
Date ..... Graded by .....

TEST No. C-1

SPECIFIC GRAVITY (DENSITY) OF PORTLAND CEMENT AND PROPERTIES OF PORTLAND CEMENT PASTE

Part A Specific Gravity (Density) of Portland Cement

Objective To determine the specific gravity of portland cement

Material Portland cement

References TIS (Thai Industrial Standard) 15 Part 2
ASTM Designation : C 188
BS (British Standard) 4550
JIS (Japan Industrial Standard) R 5201

Apparatus
(1) Standard Le Chaterier flask
(2) Kerosene free of water
(3) Long thistle funnel
(4) Thermometer
(5) Balance with 100 mg in reciprocal sensibility
(6) Water bath

Significance and Use

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

Procedures

1. Fill the standard Le Charterier flask with either Kerosene or Naphtha oil[1] to a point on the stem between zero and the 1 ml. mark. The inside of the flask above the level of the liquid must be dried.

2. Leave the flask standing in a constant temperature water bath, maintained at about room temperature, for a sufficient interval before making any of reading. The temperature of liquid in the flask should not fluctuate by more than 0.2 ^{o}C.

3. All reading should be made when the level of kerosene in the flask has become constant to ensure the contents of the flask have reached the temperature of the water bath.

4. Make the initial reading of the kerosene in the flask. Record also the temperature of the kerosene in the flask.

5. Determine the initial weight of cement and pan. A weighed quantity of cement (approximately 65 g) of the same temperature as the liquid is gradually introduced to the flask. Care must be taken to avoid splashing and to see that the cement does not adhere to the inside of the flask above the kerosene. A vibrating apparatus may be used to accelerate the introduction of cement into the flask and to prevent the cement from sticking to the neck of flask.

6. After the level of kerosene appeared between the upper graduations of the flask, stop pouring the cement. The stopper shall be placed in the flask and the flask rolled in an inclined position, or gently whirled in a horizontal circle, so as to free the cement from air until no further air bubbles rise to the surface of the liquid.

7. Leave the flask standing in the water bath again, record the final reading accordance with paragraphs 2 and 3. The difference between the initial and the final readings represents the volume of liquid displaced by the weight of cement used in the test, V_C.

8. Record the final weight of the cement and pan. The difference between the initial and the final reading represents the weight of cement used, W_C.

9. If the specific gravity of water is equal to unity. The specific gravity of cement can be calculated as follows:

$$\text{Sp.gr.} = \frac{Wc}{Vc}$$

10. To wash out the cement and clean the flask use either Kerosene or Naphtha oil. Do not allow any water to get into the flask.

11. The specific gravity test should be carried out not less than two times for each sample, and the results should agree within 0.03[2].

[1] Specific gravity of Kerosene or Naphtha oil must not less than 0.731 according to TIS.

[2] Should agree within 0.01 according to ASTM and JIS.

Part B Normal Consistency of Portland Cement

Objective — To determine the normal consistency of hydraulic portland cement with Vicat apparatus.

Material — Portland cement

References — TIS (Thai Industrial Standard) 15 Part 8
ASTM Designation : C 187
BS (British Standard) 4550
JIS (Japan Industrial Standard) R 5201

Apparatus
(1) Vicat Apparatus
(2) Glass graduates with 200 or 250 ml capacity
(3) Balance with 1000 g in weighing capacity and 1 g in reciprocal sensibility.
(4) Trowel

Significance and Use

This test method is intended to be used to determine the amount of water required to prepare hydration of hydraulic cement paste.

Procedures

1. Preparation of Cement Paste

1.1 By Hand Mixing

a) Place approximately 500 g of cement sample on the state plate and form a crater in the center. Pour the measured quantity of water in to the crater. Use the trowel to turn the cement on the outside edge into the crater in 30 sec. Leave the cement to absorb water a further 30 sec to reduce any evaporation loss, lightly trowel the cement around the cone.

b) Complete the operation by continuous, vigorous mixing, squeeze and kneading with the hands for 90 sec. Use rubber gloves to protect your hands during operation.

1.2 By Mechanical Mixer

a) Place the dry paddle an the dry bowl in the mixing position in the mixer.

b) Place all the mixing water in the bowl and add cement to the water. Allow 30 sec for the absorption of water.

c) Start mixing at slow speed (approximately 140 ± 5 rpm) for 30 sec. Stop the mixer for 15 sec and during this time scrape down into the batch any paste that may have collected on the sides of the bowl.

d) Start mixing again at medium speed (approximately 285 ± 10 rpm) for 150 sec.

2. Molding of Test Specimen

a) Quickly mold the specimen in (1) into a ball with the gloved hands and tossed 6 times from one hand to the other, maintaining the hands about 150 mm from one hand to another.

b) Press the ball, resting in the palm of one hand, into the larger end of the conical mold, completely filling the mold with the cement paste. Remove any excess at larger end by a single movement of the palm of the hand.

c) Place the larger end of the mold on a glass plate and sliced off any exceed of cement paste at the top of the mold by a single oblique stroke of a sharp-edged trowel held at a slight angle with the top of the mold. Care should be taken not to compress the paste.

3. Consistency Determination

a) Center the mold under the rod of Vicat apparatus and bring the larger plunger into contact with the surface of the paste and tighten the set-screw.

b) Set the movable indicator to the upper zero mark of the scale or read the initial reading.

c) Release the rod within 30 sec after completion of mixing. The apparatus shall be free from all vibrations during the test. record the penetration of Vicat rod at the end of 30 sec. The paste shall be of normal consistency if the rod settles to a point 10 ± 1 mm below the original surface in 30 sec after being released.

d) Make more trial paste with varying percentage of water until the normal consistency is obtained. Each trial must be made with fresh cement paste.

e) Plot the curve of quantity of water as ordinate and penetration of Vicat rod as abscissa in order to determine the correct normal consistency to the nearest 0.1%.

Part C Initial Setting Time of Portland Cement by Vicat Needle

Objective — To determine the initial setting time of hydraulic portland cement with Vicat apparatus.

Material — About 500 g of portland cement

References — TIS (Thai Industrial Standard) 15 Part 9
ASTM Designation : C 191
BS (British Standard) 4550
JIS (Japan Industrial Standard) R 5201

Apparatus — The same as Part B.

Procedures

1. Preparation of Cement Paste

Repeat the operation of Part B (1) and (2) by using the percentage of mixing water required for normal consistency. Place the mold on the glass plate directly under the Vicat apparatus.

2. Initial Setting Time Determination

a) Allow the time of setting specimen to remain in the moist cabinet for 30 min after molding without being disturbed. Then bring the 1 mm needle[3] into contact with the surface of the paste and tighten the set-screw.

b) Set the moveable indicator to the upper zero mark of the scale or read the initial reading and quickly release the needle or plunger.

c) Record the elapsed time after water is added to cement and the penetration of the needle in 30 sec after being released. Thereafter every 15 min (10 min for ASTM Type III) until the penetration of 25 mm or less is obtained.[4,5] No penetration test shall be made closer than ¼" (6.4 mm) from any previous penetration or 3/8" (9.5 mm) from the inside of the mold.

d) Record the results of all penetration tests and determine the time when a penetration of 25 mm (or the penetration of plunger 6 mm from the bottom) is obtained by the interpolation technique. This is considered as the initial setting time. The ASTM specification specified not less than 45 min for ordinary portland cement.

[3] JIS use 10 mm diameter standard rod or plunger.

[4] A penetration of a standard rod or plunger of 6 mm from the bottom is used for JIS.

[5] According to the British Standard when the penetration of the plunger is 5 ± 1 mm from the bottom, initial setting is said to have taken place.

Sketch all necessary figures about the test

Experimental Data and Results

Part A Specific Gravity (Density) of Portland Cement

	Sample 1		Sample 2	
	1	2	1	2
Type of cement				
Initial flask reading, ml				
Initial kerosene temperature, ^oC				
Initial weight of cement & pan, g				
Final flask reading, ml				
Final kerosene temperature, ^oC				
Final weight of cement & pan, g				
Weight of cement used, W_c, g				
Volume displaced, V_c, ml				
Specific gravity				
Average specific gravity				

Part B Normal Consistency of Portland Cement

Cement No. 1					Cement No. 2				
No.	Cement (g)	Quantity of water (%)	Quantity of water (g)	Penetration Of rod	No.	Cement (g)	Quantity of water (%)	Quantity of water (g)	Penetration of rod
1					1				
2					2				
3					3				
4					4				
5					5				
6					6				
7					7				
8					8				
9					9				
10					10				
Normal consistency (%)					Normal consistency (%)				

Part C Initial Setting Time of Portland Cement by Vicat Needle

Cement No.1		Cement No. 2	
Elapsed time (min)	Penetration in 30 sec (mm)	Elapsed time (min)	Penetration in 30 sec (mm)
Initial setting time (min)		Initial setting time (min)	

Sample of Calculations

Summary of Results (in Tabular Form), Discussion and Conclusion