University of the Cordilleras
College of Engineering and Architecture
Department of Civil Engineering

CONSISTENCY OF STANDARD CEMENT PASTE

In Partial Fulfillment of the Requirements in
CMT - CONSTRUCTION MATERIALS AND TESTING
Third Term, 2020 - 2021

Submitted by:
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Submitted to:
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MSCE

June 11, 2021

Name: ___Antero, Audrey C._________
Group No. :__________________
Date Performed: ___June 11,2021_________

LABORATORY WORK NO. 9: CONSISTENCY OF STANDARD CEMENT PASTE

OVERVIEW:

Consistency one property of freshly mixed concrete, is an important consideration in securing a workable concrete that can be properly compacted in the forms. The term consistency relates fluidity from the driest to the wettest mixtures. The common test to determine consistency are the "slump" test and the "ball penetration" test. These tests give only rough measures of consistency, but they do give satisfactory measures of this property for most practical work.

For convenience, various degrees of wetness of a mix may be roughly classified as dry, tiff, medium, wet, or sloppy. A concrete is said to have medium or plastic consistency when it is just wet enough to flow sluggishly, not so dry that it crumbles or so that water or paste runs from the mass.

The principal factors affecting consistency are: the relative proportions of cement to aggregates, the water content of aggregate, the size of aggregate, the shape and surface characteristics of the aggregate particles, and the fineness and type of cement and the kind and amount of a mixture.

The aim of this experiment is to find out for a given cement, the quality of water to be mixed, should give a paste of normal consistency.

ESSENTIAL MATERIALS AND EQUIPMENT:

1. Sample of portland cement
2. Balance
3. Spatula
4. Pan
5. Trowel
6. Graduated cylinder
7. Vicat apparatus
8. Rubber mold

TESTING PROCEDURE:

1. Weigh accurately about 300 gm of neat cement sample to be tested.

2. Mix about 25% of a clean water to the cement by spatula.

3. After about a minute, mixed it thoroughly with hands for at least one minute.

4. The kneaded paste is formed into a ball and tossed about six times from one hand to another.
5. The ball is then pressed into a rubber mold and the excess paste is removed.

6. The larger end of the rod is brought in contact with the surface of the paste and reading on the scale is taken.

7. The rod is then quickly released without any jerk and penetration noted. If the rod penetrates by 33 to 35 mm the paste is said to be of normal consistency.

8. The time taken between adding of water to cement and the filling of the mold should be between 3 to 5 minutes.

9. Trial paste should be made with varying percentage of water to determine the percentage for which the desired penetration is obtained. The amount of the water is expressed as a percentage by weight of dry cement usually 30%.

Approximate range in slump of concrete for various degrees of consistency:

Consistency	**Slump, mm**	**Remarks**
Dry	0 - 25	Crumbles and fall apart under ordinary handling; can be compacted into rigid mass under vigorous ramming, heavy pressure or vibration, but unless care is used to exhibit voids or honeycombs.
Stiff	15 -65	Tends to stand as a pile; holds together fairly well but crumbles if chuted; with care and effort can be tamped into solid dense mass; satisfactory for vibratory compaction.
Medium	50 - 140	Alternate terms; plastic, mushy quaking, easily molded although some care required to secure complete compaction.
Wet	125 - 200	Pile flattens readily when dumped; can be poured into place.
Sloppy	175 - 250	Group or mortar tends to run out of pile, leaving coarser material behind.

DISCUSSIONOF THEORY: (Related Literatures about the Laboratory Work Topic minimum of 3 pages, cite your references properly. APA Style eg. Author/s (YEAR OF PUBLICATION))

APENDICIES:

I. Detailed Computations: (IF APPLICABLE)
II. References: (Use APA Style of Citation) eg. Last Name Author, Initials (YEAR) Title of Journal (Book), Chapter page range, Location (publisher)
III. ASTM/AASHTO Standards (will be provided)

DISCUSSION OF THEORY:

A. Title: Influence of Nano-SiO2 on the Consistency, Setting Time, Early-Age Strength, and Shrinkage of Composite Cement Pastes

B. Author/s: Chen, Y.,Deng, Y., & Li, M.

C. Literature Review:

Title: Influence of Nano-SiO2 on the Consistency, Setting Time, Early-Age Strength, and Shrinkage of Composite Cement Pastes

Author/s: Chen, Y.,Deng, Y., & Li, M.

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A. Title: Influence of Nano-SiO2 on the Consistency, Setting Time, Early-Age
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B. Author/s: Chen, Y.,Deng, Y., & Li, M.

C. Literature Review:

The effects of adding nano-silica (SF) to the consistency, setting time, early-age strength, and shrinkage of composite cement pastes were investigated in this study. Silica fume (SF) has long been used to improve the characteristics of cement. The addition of nano silica to cement, with the advent of nanotechnology, improves the characteristics of cement more than the addition of silica fume. It was found that nano-silica, in little amount, decreased water demand and increased workability of cement, larger amount increased water demand. Supporting research has shown that adding a little amount of nano silica to a hardened mixture improves the mechanical characteristics.

Ordinary Portland cement, fly ash, silica fume, and amorphous silica were employed in the investigation to enhance homogeneity, nano-silica, and Poly-carboxylic superplasticizer (SP) are used NS and SF particles are dispersed. Cement pastes were made with varied amounts of SF and NS for comparison, and homogeneity was achieved using an ultrasonic mixer with a 90W input. In compliance with GB 1346-2011, consistency and setting time were evaluated. For compressive and bending strength tests, paste was molded on 40mm cubes and 40 x 40 x 160 mm beams, respectively. ASTM C1608-2012 and ASTM C1698-2014 were used to perform chemical and autogenous shrinkage, respectively. All the data was in effective average value.

The results showed that the increasing amount of SF and NS also increases the necessary amount of SP for standard consistency. Generally, NS requires less SP than SF to achieve standard consistence; addition of 30% FA in mass percentage also results to the same conclusion. NS increases mix viscosity due to its very high specific surface areas caused by its nano-sized particles resulting to lower SP dosage to control the mixture's viscosity.

With the addition of either SF or NS, the setting time was reduced; nonetheless, NS had a faster initial and final set than FS, even when FA was added to the NS mixtures. The reduction in time is primarily due to the reduction in initial setting time. Because of its high specific surface areas, NS decreases setting time and speeds up the pace of hydration.

NS and SF both enhanced their early-age compressive strength, although SF's strengthening impact is smaller than NS's, which is more apparent in bending strength. Also, adding a lot of FA reduces compressive strength before 7 days but enhances bending strength.

Cement pastes shrink chemically and autogenously when the amount of SF or NS increases. NS, on the other hand, is more effective than SF at causing early age shrinking due to its incredibly small particles.
The addition of NS changes the microstructure of the mixture, making it denser and more compact.

Reference:

Chen, Y.,Deng, Y., & Li, M. 2016. Influence of Nano-SiO2 on the Consistency, Setting Time, Early-Age Strength, and Shrinkage of Composite Cement Pastes

ASTM/AASHTO Standards:

ASTM C1608-2012

ASTM C1698-2014

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DETERMINATION OF SETTING TIME OF PORTLAND CEMENT

In Partial Fulfillment of the Requirements in
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Submitted by:
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LABORATORY WORK NO. 10: DETERMINATION OF SETTING TIME OF PORTLAND CEMENT

DISCUSSION:

The initial set is a stage in the process of hardening after which any cracks that may appear will not reunite. The concrete is said to be finally set when it has attained sufficient strength and hardness.

REFERENCE:

ASTM C 191-71
AASHTO T 131-74

ESSENTIAL EQUIPMENT AND MATERIALS:

a. Portland Cement
b. Vicat Apparatus
c. Rubber Mold
d. Balance sensitive to 0.1 gm.
e. Mixing container
f. Graduated cylinder
g. Spatula

TESTING PROCEDURES:

1. Test for fineness of cement.

2. Weigh about 300 gms. of cement accurately and make a paste with 0.85 times the water required to make a paste of normal consistency.

3. The paste is then placed in the rubber mold.

4. The small end of the rod is brought in contact with the surface of the paste and quickly released.

5. The penetration of the needle can be read on the goals. The initial set is said to have occured when the needle ceases to penetrate a point 5 mm above the bottom of the mold.

6. The time taken from the instant of adding water to the cement up to the moment when the needle ceases to penetrate a point 5 mm above the bottom of the mold is known as the initial setting time of the cement. For ordinary portland cement, the initial setting time should not be less than 30 minutes.

DATA AND RESULTS:

a. weight of cement: _________615________gms

b. volume of water: ___________215________ml

c. water-cement ratio: _________1:33___________

d. initial setting time: __________4800__________sec.

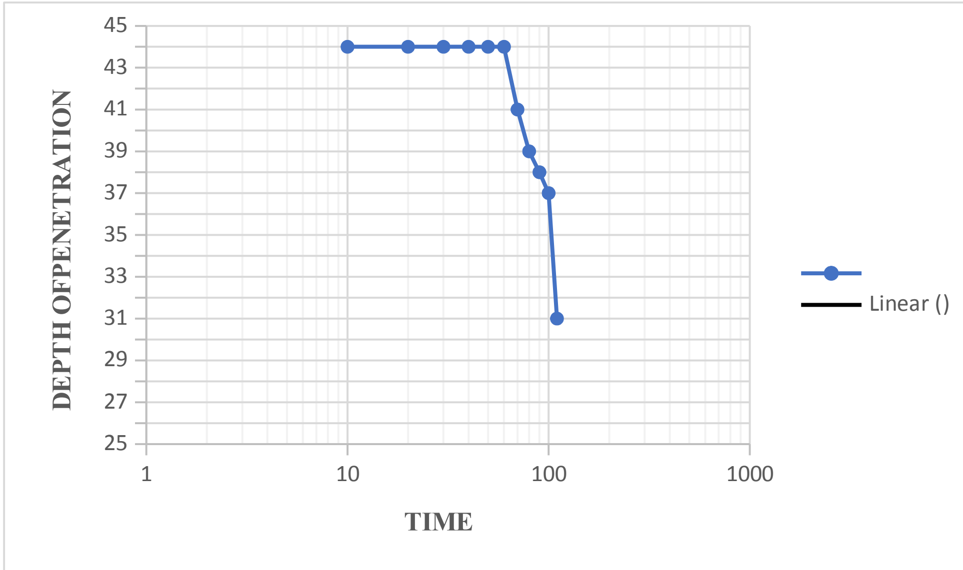
e. Final setting time: __________10___________hrs.

trials	**Time, min.**	**Depth of penetration, mm**
1	0	44
2	10	44
3	20	44
4	30	44
5	40	44
6	50	44
7	60	44
8	70	41
9	80	39
10	90	38
11	100	37
12	110	31

DISCUSSIONOF THEORY: (Related Literatures about the Laboratory Work Topic minimum of 3 pages, cite your references properly. APA Style eg. Author/s (YEAR OF PUBLICATION))

REPORT:

1. Plot a semi-logarithmic scale a curve showing the relationship between time (abscissa) and the depth of penetration (ordinate). From this curve drawn, determine the time required for a 25 mm needle penetration.



2. Explain the following:

   a. The difference between hydraulic and non-hydraulic cement.
   The primary distinction between hydraulic and non-hydraulic cement is that hydraulic cement can set and harden underwater, but non-hydraulic cement cannot. The former hardens quickly and sets because of the hydration reaction. The latter, on the other hand, requires a dry environment to set and harden, takes longer to dry, and harden, and hardens through carbonation.

   b. The Dry Process of manufacturing Portland cement.
   Raw materials for cement manufacturing are dried and reduced to a fine powder in a grinding mill in the dry process. The dry powder/raw meal is then pumped into a blending silo, where compressed air is used to combine the ingredients into a homogenous and intimate mixture. After being held in a storage tank, the mixture is fed into a rotary kiln to produce clinkers. Clinkers are subsequently processed in a ball mill with a gypsum content of 2% to 3%. It is then fed into cement silos before being packed into the proper pack at a packing plant.

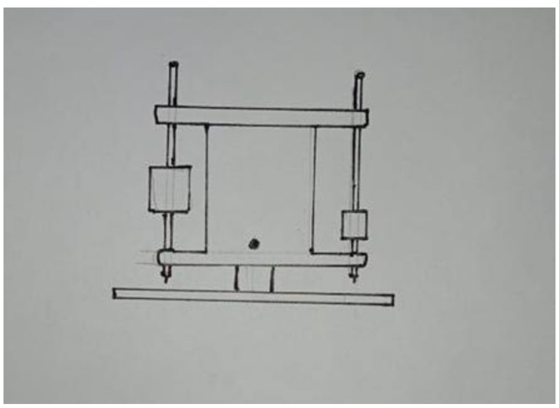
3. List eight types of Portland cement and give their uses.

a. Type I (Normal) – used in general construction that does not require any special properties of other types.
b. Type IA (Normal, air entraining) – used in general construction and adapts to freeze-thaw cycle.
c. Type II (Moderate sulfate resistance) – ideal for heavy structures like abutments, piers, and retaining walls.
d. Type IIA (Moderate sulfate resistance, air entraining) – used in heavy structures and adapts to freeze-thaw cycles.
e. Type III (High early strength) – used in constructions that is to be operational immediately, and where formwork needs to be removed and reused.

f. Type IIA (High early strength, air entraining) – used in constructions that is to be operational immediately, and where formwork needs to be removed and reused; and adapts to freeze-thaw cycle.
g. Type IV (Low heat of hydration) – suited for the construction of massive structures with a low surface-to-volume ratio, like gravity dams, where a large heat of hydration may result in dangerous cracks.
h. Type V (High sulfate resistance) – used in canal linings, retaining walls, and culverts which is prone to sulfate attacks

4. Give and describe the significant characteristics of Portland cement.
   Portland cement is a hydraulic cement, which means it can harden even while submerged in water. Because of its likeness to Portland stone, it was given that name. It's a fine powder made by clinkering limestone and clay minerals in a kiln, grinding the clinker, and adding 2 to 3 percent gypsum. It is caustic, which means it can cause chemical burns. There are various types of it.

5. Draw and describe the Gilmore apparatus.



   It is used to figure out how long it takes for cement to set. Two horizontal arms contain two weighted steel needles that have been carefully cut to satisfy the need. The beginning needle, with a diameter of 2.12 mm, weighs 113 g, whereas the final needle, with a diameter of 1.06 mm, weighs 453,6 g.

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III. ASTM/AASHTO Standards (will be provided)

DISCUSSION OF THEORY:

Title: Effects of Palm Oil Fuel Ash (POFA) Towards Consistency and Setting

Time Properties of Concrete

Author/s: Imran, N.F. , Hasri, M.N., Khairul Fitry, N.A., Hasan, D. & Ramli, M.Z.

Literature Review:

The effects of palm oil fuel ash (POFA) on concrete consistency and curing time for use in the construction of stiff pavements in Malaysia were investigated in this paper. Pozzolans are non-cementitious siliceous or siliceous and aluminous materials that improve the workability, strength, and durability of concrete. Because finer particle size enhances packing and pozzolanic activity, which leads to increased durability, their particle size/fineness has a significant impact on the qualities of mortar or concrete.

POFA (palm oil fuel ash), whose disposal is a concern in Malaysia, is a pozzolanic substance that improves the compressive strength of concrete. The more finely it is ground or burned, the more compressive strength it will provide to the concrete.

POFA samples were acquired from a palm oil plantation and prepared by oven drying for 24 hours, sieving at 212 micrometers, and liquifying at 1kg:200mL water. The consistency and setting time tests were performed in accordance with BS EN 196-03:2005 and ASTM-C 150-09, respectively.

Regardless of the proportion of POFA and water in each sample, the consistency test revealed the same penetration. The powder methodology revealed that a higher POFA % equals a higher water percentage for achieving standard uniformity. The highest water percentage using this approach is 5% POFA. The liquidation procedure produced the same outcomes with 5% POFA as the one with the greatest water percent. According to the journal, the shape and fineness of pozzolan are important in obtaining low water content.

The powder method setting time test revealed that a larger percentage of POFA equals a longer setting time. The beginning and final setting times for 5% POFA are the longest. The liquidation procedure produced the same results, but with a longer setting time for the POFA-added mixtures.

REFERENCE:

Imran, N.F. , Hasri, M.N., Khairul Fitry, N.A., Hasan, D. & Ramli, M.Z. 2013. Effects of Palm Oil Fuel Ash (POFA) Towards Consistency and Setting Time Properties of Concrete

ASTM/AASHTO Standards:

ASTM C 191-71

AASHTO T 131-74