Concrete Technology
Live Session 2

7 Feb 2022

Session starts at 6 pm

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Nilakanmani Manimaran (NPTEL TA)

Doctoral Research Scholar

PMRF Candidate

Indian Institute of Technology Madras

Chennai, India

Course Instructor: Prof. B. Bhattacharjee

Solving Practice Questions

Question 1

Which of the following is correct wrt Rapid Hardening Portland Cement (RHPC) or ASTM Type III cement?

a) Low C3S & Low C3A

b) High C3S & Low C3A

c) High C3S & High C3A

d) Low C3S & High C3A

Question 1

Rapid Hardening Portland Cement (RHPC) or ASTM Type III cement

Types of Cement

- Modified Cement (ASTM TYPE II)

Cem	C_3S	C_2S	C_3A	C_4AF	CS^{-}	Fr C	LOI
I	59	15	12	8	2.9	0.8	1.2
II	46	29	6	12	2.8	0.6	1.0
III	60	12	12	8	3.9	1.3	1.9
IV	30	46	5	13	2.9	0.3	1.0
V	43	36	4-5	12	2.7	0.4	1.0

Question 1

Which of the following is correct wrt Rapid Hardening Portland Cement (RHPC) or ASTM Type III cement?

a) Low C3S & Low C3A

b) High C3S & Low C3A

c) High C3S & High C3A

d) Low C3S & High C3A

Question 2

True (or) False:

Statement: Capillary meso pores is primarily responsible for the shrinkage and creep of the hardened cement paste.

a) True

b) False

Question 2

- ***Gel is colloid sized particles having 28% characteristic porosity involving pores of average width15Å, called gel pores***

Gel pores: micro pores (0.5nm -- 100nm)(Shrinkage & Creep)

Capillary meso pores (5 nm-5000nm) (Mechanical & Durability)

Macro pores due to air entrainment

Macro pores due to poor compaction

Question 2

True (or) False:

Statement: Capillary meso pores is primarily responsible for the shrinkage and creep of the hardened cement paste.

a) True

b) False

Question 3

Calculate the chemically combined water at complete hydration for one gram of cement of the given compositions. (*W/C* = 0.4)

a) C3S = 46%, C2S = 29%, C3A = 6%, C4AF = 12% **(ASTM Type II cement)**

b) C3S = 60%, C2S = 12%, C3A = 12%, C4AF = 8% **(ASTM Type III cement)**

Question 3

a) C_3S = 46%, C_2S = 29%, C_3A = 6%, C_4AF = 12% (ASTM Type II cement)

$$\frac{W_n}{C} = a_1(C_3S) + a_2(C_2S) + a_3(C_3A) + a_4(C_4AF)$$

W/C = 0.4, T = 13 years, a_1 = 0.230, a_2 = 0.196, a_3 = 0.522, a_4 = 0.109

$W_n = (0.230 \times 0.46) + (0.196 \times 0.29) + (0.522 \times 0.06) + (0.109 \times 0.12)$

$W_n = 0.207 \approx 0.21$ **(Range → 0.20 to 0.21)**

Question 3

b) C_3S = 60%, C_2S = 12%, C_3A = 12%, C_4AF = 0.08% (ASTM Type III cement)

$$\frac{W_n}{C} = a_1(C_3S) + a_2(C_2S) + a_3(C_3A) + a_4(C_4AF)$$

W/C = 0.4, T = 13 years, a_1 = 0.230, a_2 = 0.196, a_3 = 0.522, a_4 = 0.109

$W_n = (0.230 \times 0.60) + (0.196 \times 0.12) + (0.522 \times 0.12) + (0.109 \times 0.08)$

$W_n = 0.2328 \approx 0.23$ **(Range → 0.23 to 0.24)**

Question 4

Which of the following statements are not correct?

a) Non-hydraulic lime reacts with CO_2 to form $CaCO_3$ and hardens

b) Non-hydraulic lime sets by losing moisture to environment

c) Hydraulic lime hardens due to reaction between active clay and lime

d) None of the above

Question 4

Which of the following statements are not correct?

a) Non-hydraulic lime reacts with CO_2 to form $CaCO_3$ and hardens

b) Non-hydraulic lime sets by losing moisture to environment

c) Hydraulic lime hardens due to reaction between active clay and lime

d) None of the above

Recap from lectures

- For complete hydration of 1 gram of cement → 0.23 gram water required
- Density of solid hydration products ≈ 2.51 gm/cc
- Degree of hydration(h) = Cement reacted/Total cement
- Cement taken = C gm; Water taken = W gm
- Vol of cement = C/3.15 = 0.32C cc
- Vol of water = W cc
- Vol of reactants = (0.32C + W) cc

- Mass of cement reacted = Ch gm
- Mass of solid hydration product = Ch + 0.23Ch = 1.23Ch gm
- Vol of solid hydration products = mass/density = 1.23Ch/2.51 = 0.49Ch cc
- Gel pores = 28% of total hydration product
- Gel pores = (0.49Ch × 0.28)/0.72 = 0.19Ch cc
- Mass of unreacted cement = C(1-h) gm
- Vol of unreacted cement = C(1-h)/3.15 = 0.32C(1-h) cc

Recap from lectures

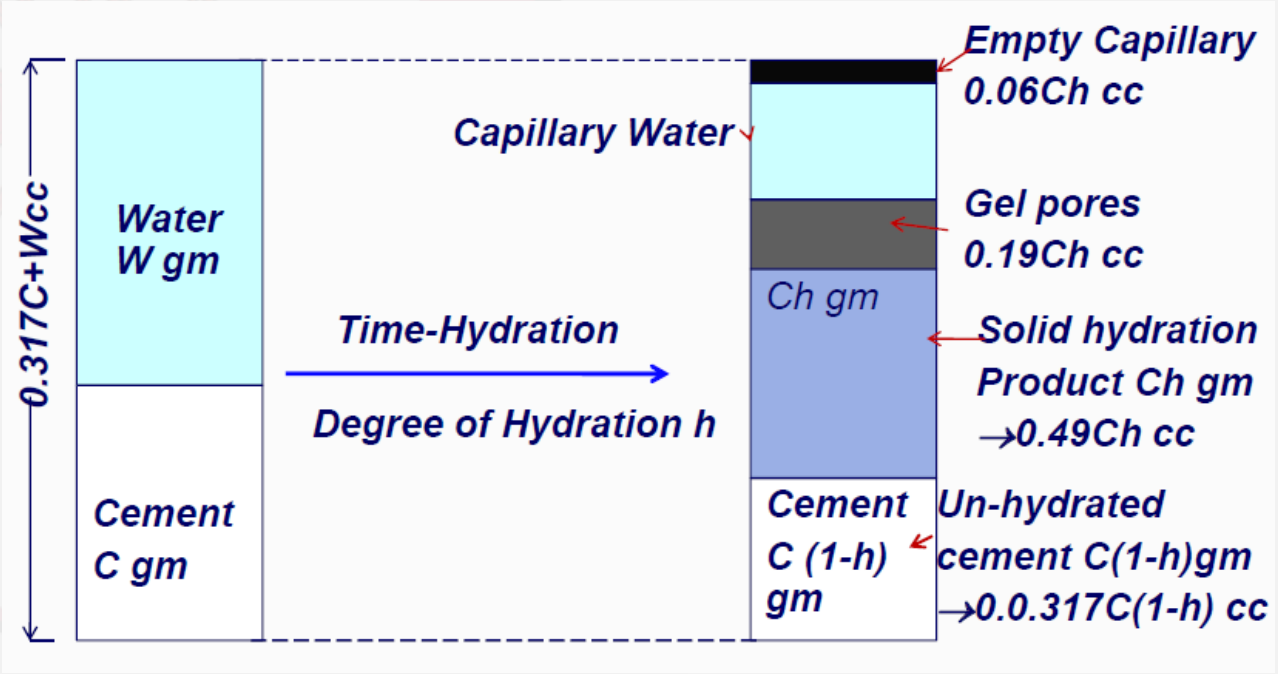
- Vol reacted = Ch/3.15 + 0.23Ch = 0.55Ch cc
- Vol of empty capillary pore = Volume reacted – volume of solid hydration product
- Vol of capillary pore = 0.55Ch – 0.49Ch = 0.06Ch cc
- Vol of capillary water = Vol of reactants – vol of unhyd. cement – vol of solid hyd. product – vol of gel pores –vol of empty capillary pore

= (0.32C + W) – (0.32C(1-h)) – 0.49Ch – 0.19Ch – 0.06Ch

= W – 0.42Ch

- Vol of capillary pores = vol of empty capillary pores + vol of capillary water

= 0.06Ch + W – 0.42Ch = W – 0.36Ch



Recap from lectures

- Porosity =Volume of Pores ÷ Total Volume
- Capillary porosity Pc = Volume of capillary pores ÷ Total Volume → $P_c = \dfrac{\frac{W}{C} - 0.36h}{0.317 + \frac{W}{C}}$
- Gel porosity Pg = Volume of gel pores ÷ Total Volume → $P_g = \dfrac{0.19h}{0.317 + \frac{W}{C}}$
- Total Porosity =Volume of Pores ÷ Total Volume = Pc +Pg → $P_T = \dfrac{\frac{W}{C} - 0.17h}{0.317 + \frac{W}{C}}$
- At, maximum degree of hydration, Pc = 0

$$P_c = \frac{\frac{W}{C} - 0.36h}{\frac{W}{C} + 0.32} = 0;\ Thus,\ h_{\max} = \frac{\left(\frac{W}{C}\right)}{0.36}$$

$h = \frac{W/C}{0.36}$

$\frac{W}{C} - 0.36h = 0$

$\frac{W}{C} = 0.36h$

Question 5

A cement paste prepared with 300 gm of cement has a water cement ratio (W/C) pf 0.4, what is the capillary porosity at the end of one year assuming that maximum hydration has taken place.

a) 0

b) 0.25

c) 0.5

d) 0.75

Question 5

A cement paste prepared with 300 gm of cement has a water cement ratio (W/C) pf 0.4, what is the capillary porosity at the end of one year assuming that maximum hydration has taken place.

$$Pc = \frac{\frac{W}{C} - 0.36h}{\frac{W}{C} + 0.32}$$

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$$Pc = \frac{\frac{W}{C} - 0.36h}{\frac{W}{C} + 0.32}$$

$$Pc = \frac{0.4 - 0.36}{0.4 + 0.32}$$

$$= 0.05 \approx 0$$

Question 5

A cement paste prepared with 300 gm of cement has a water cement ratio (W/C) pf 0.4, what is the capillary porosity at the end of one year assuming that maximum hydration has taken place.

a) 0

b) 0.25

c) 0.5

d) 0.75

Question 6

A cement paste was prepared with 200 gm of cement and a water cement ratio of 0.25. Calculate the volume of gel pores at the end of one year assuming maximum hydration has taken place in one year.

Answer: _____

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$V_g = 0.19Ch$

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$Vg = 0.19Ch$

$Vg = 0.19 \times 200 \times 0.25/0.36$

$Vg = 26.38$

Question 6

A cement paste was prepared with 200 gm of cement and a water cement ratio of 0.25. Calculate the volume of gel pores at the end of one year assuming maximum hydration has taken place in one year.

Answer: 25 - 28

Question 7

If the mean sieve size is 8 mm, what size particles will be considered as flaky:

a) Having thickness less than 4.8 mm

b) Having thickness more than 4.8 mm

c) Having length more than 14.4 mm

d) Having length less than 14.4 mm

Question 7

If the mean sieve size is 8 mm, what size particles will be considered as flaky:

Code restricts use of flaky or elongated aggregate
A particle is flaky if thickness<0.6 mean (arithmatic) sieve size
A particle is elongated if length>1.8 mean sieve size

Thickness < 0.6 × 8
Thickness < 4.8

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c) Having length more than 14.4 mm

d) Having length less than 14.4 mm

Thank You