Lecture 4

Volume of hydration products, Examples

Example1:

Find the volume of the hydration products for a reaction between 100g of cement with 42g of water. Assume that the reaction occurred in a sailed container.

Solution:

w/c ≥ 0.42 then, no unhydrated cement will appear after reaction

$V_s = V_c + 0.23C - 0.254 \times 0.23\ C$

$V_s = 100/3.15 + 0.23 \times 100 - 0.254 \times 0.23 \times 100$

$= 48.9$ ml

$W_g = 0.28(V_s + W_g)$

$W_g = 0.28\ (48.9 + W_g)$

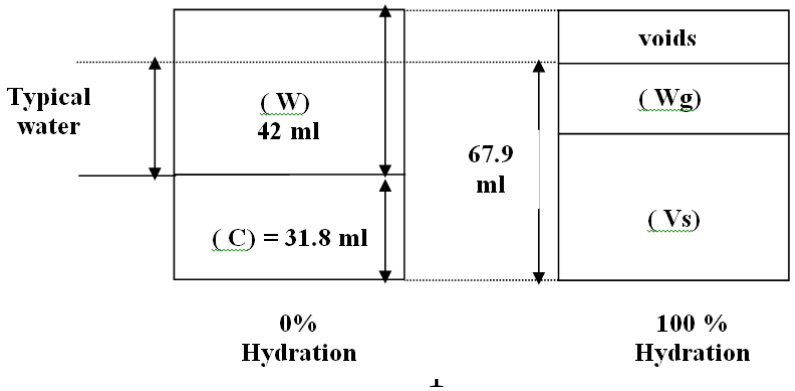
$W_g = 19$ ml

Volume of hydrated cement = 19 + 48.9 = 67.9 ml

Volume of voids = 67.9 - (31.8 +42) = 5.9 ml

Volume of fully voids with water = (19 + 0.23 ×100) – 42 = 0 ml (why)

Volume of empty voids = 5.9 ml



Example 2: Find the volume of hydration products for a reaction of 100g of cement with 30g of water. Assume that the reaction occurred in a sailed container.

Solution:

w/c ≤ 0.42 then, unhydrated cement will appear after reaction) a part of cement will react = x)

$V_s = x/3.15 + 0.23x – 0.254 \times 0.23x$

$Vs = 0.489x$ ml

$W_g = 0.28 (0.489x + W_g)$ …….Eq 1

$W_{total} = W_g$ + combined water (0.23 C)

$40 = W_g + 0.23 x$ …….Eq 2

Solve the two eqs.

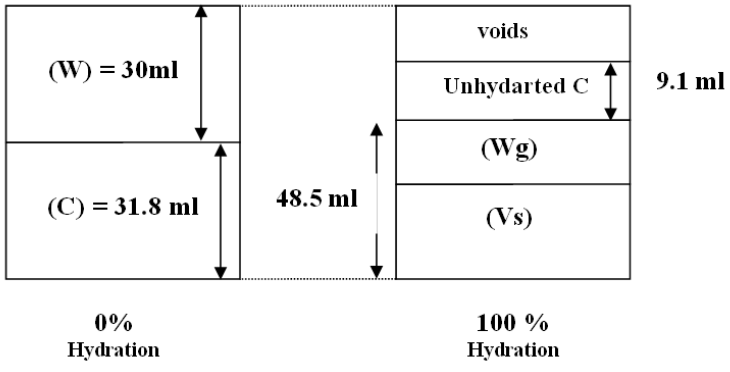
x= 71.5 g =71.5/3.15 = 22.7 ml ……. Specific gravity of C = 3.15

W_g= 13.5 g = 13.5 ml

Volume of hydrated cement = 13.5 + 71.5 × 0.489 = 48.5 ml

Volume of unhydrated cement = 100/3.15- 22.7 = 9.1 ml

Volume of voids = (100/3.15 + 30) – (48.5 +9.1) = 4.2 (they will be empty for sure because insufficient water is used)



Example 3: For 50 % degree of hydration, find the volume of hydration products for a reaction of 126g of cement with w/c = 0.475. Assume that the reaction occurred in a sailed container.

Solution:

w/c $\geq$ 0.42 then, no unhydrated cement will appear after reaction. However, there will be unhydrated cement for 50% degree of hydration.

V_s = [126/ 3.15 + 0.23 × 126 – 0.254 × 0.23 *126] ×50%

V_s = 30.8 ml

W_g = 0.28 (30.8 + W_g)

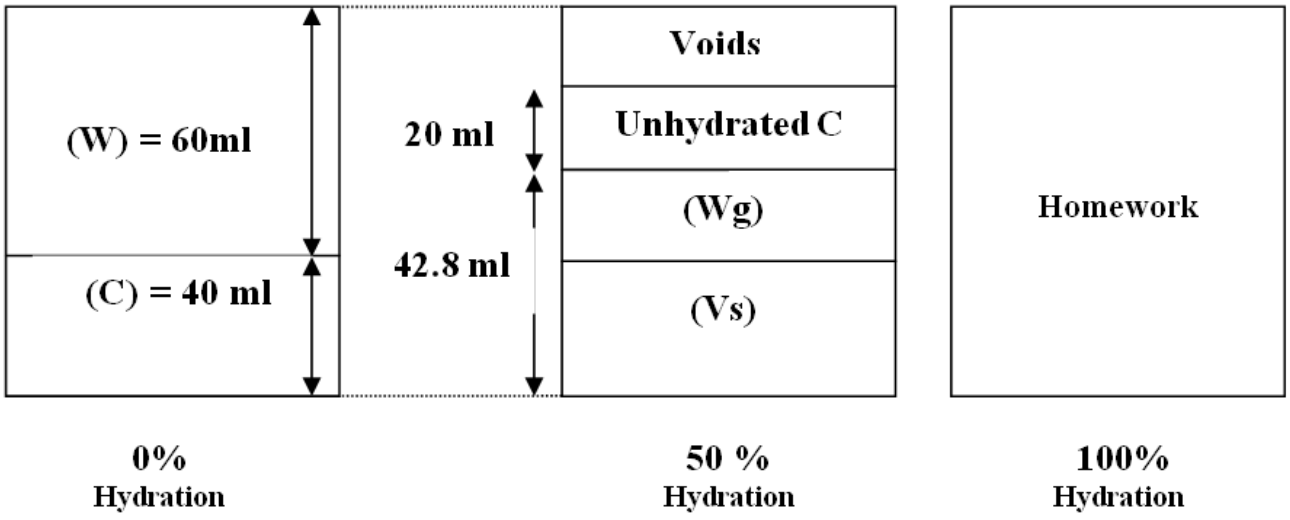
W_g = 0.28 (30.8 +W_g)

W_g = 12 ml

Volume of unhydrated cement = 126/3.15 × 50% = 20 ml

Volume of fully voids = 60 – (12 + 0.23 × 126 × 0.5) = 33.5 ml

Volume of empty voids = 37.5 – 33.5 = 4 ml



After knowing the structure of a hydrated cement paste:

What are the ideas in your mind to develop the concrete?

How we can benefit from this information for the real concrete work?