

Pore Structure Analysis of Hardened Cement

Overview

It is known that the strength and durability of concrete are affected largely by the pore structure of hardened cement and the moisture contained in the pores. Here, we will present our evaluation of the pore volume and pore size distribution at various cement setting times using the mercury intrusion method. An evaluation of He true density and pore rate by the gas substitution method is also presented.

Results

Sample: Cement (setting time 10h to 4w¹)

Figure 1 Cumulative pore volume by mercury intrusion method

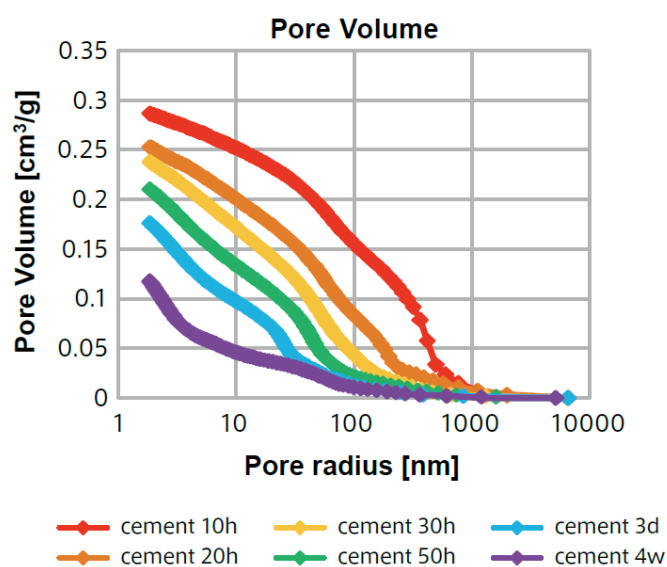


Figure 2 Pore distribution analysis by mercury intrusion method

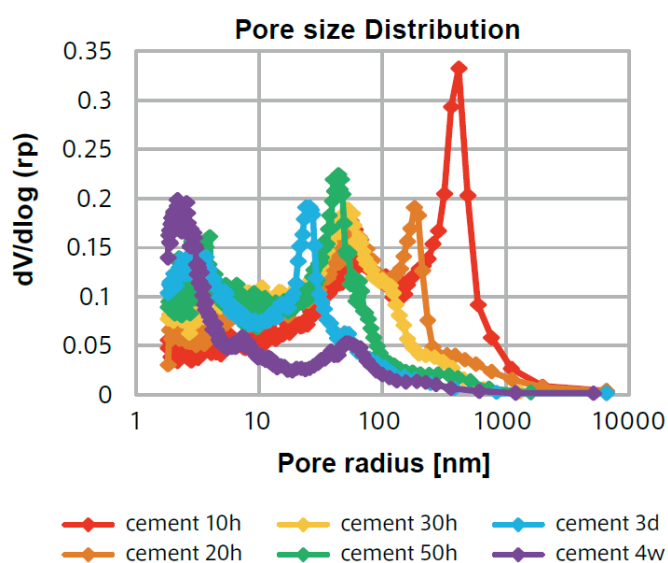


Table 1 He true density and pore rate by gas substitution method

| Cement setting time | 10h | 20h | 30h | 50h | 3d | 4w |
|---------------------------|--------|--------|--------|--------|--------|--------|
| Density g/cm ³ | 2.7498 | 2.6574 | 2.6136 | 2.5403 | 2.4865 | 2.3641 |
| Porosity %*2 | 41.93 | 37.06 | 35.51 | 32.10 | 28.59 | 20.28 |

*1 h: hour, d: day, w: week *2 Percentage of pores with a diameter ≥ 3.6 nm

Discussion

The evaluation by the mercury intrusion method revealed that as the setting time became longer, the pore size decreased and the pore volume also became smaller.

We may consider that during the early stage of cement setting, voids (macro-spores) between particles are primarily formed and that during the later stages of setting, the voids and micro-spores are increasingly filled, resulting in a smaller pore size. In addition, the He true density and pore rate also tended to decrease as the setting time became longer.

Thus, data important for evaluation of the strength and durability of hardened cement may be collected by measuring the voids between cement particles and the pore size/volume using the mercury intrusion method and the gas substitution density measurement method.

Apparatus

Mercury Porosimeter

Principle of measurement:
Pore distribution measurement
by the mercury intrusion method
Range of measurement:
950-0.0036 μm

True Density Measurement System BELPYCNO

Principle of measurement: Gas substitution
Cell capacity: 1.0, 3.5, 10 cm³

Features :

- 1) High-resolution one-touch measurement
- 2) High-precision measurement with a mechanism allowing to change the volume of the inflating chamber



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