

Innovative technique for fresh concrete property assessment



Zongjin Li

The Hong Kong University of Science and technology

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HKUST

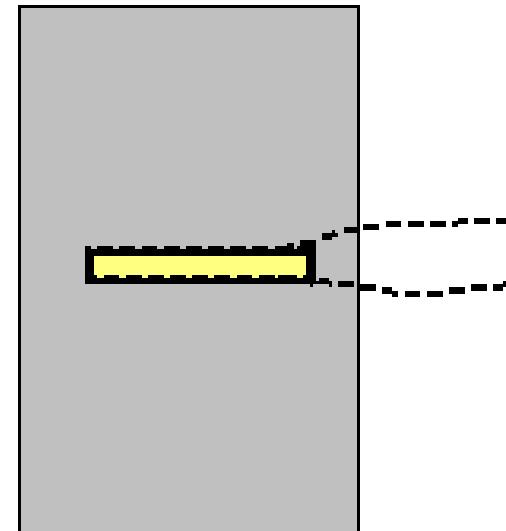


Cement-based piezoelectric sensor

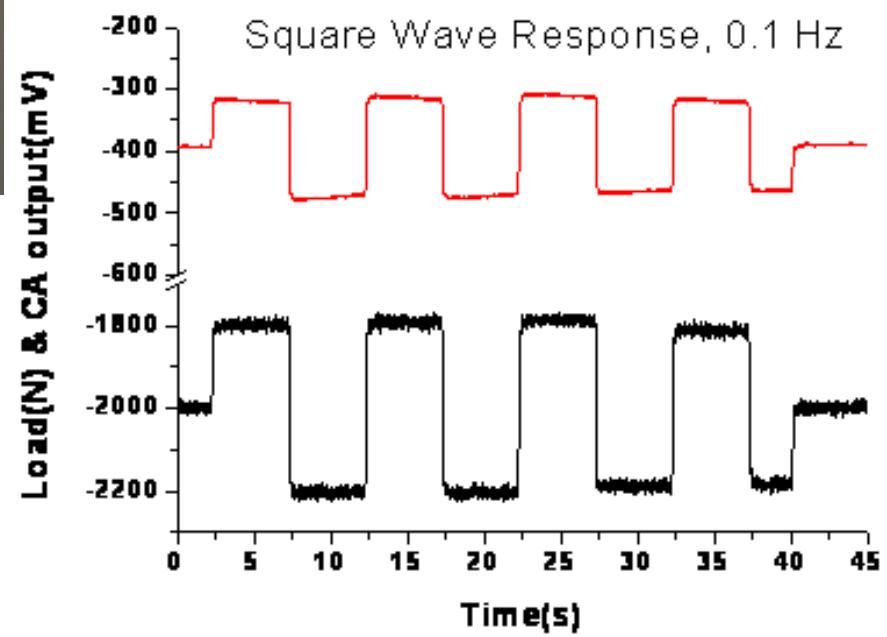
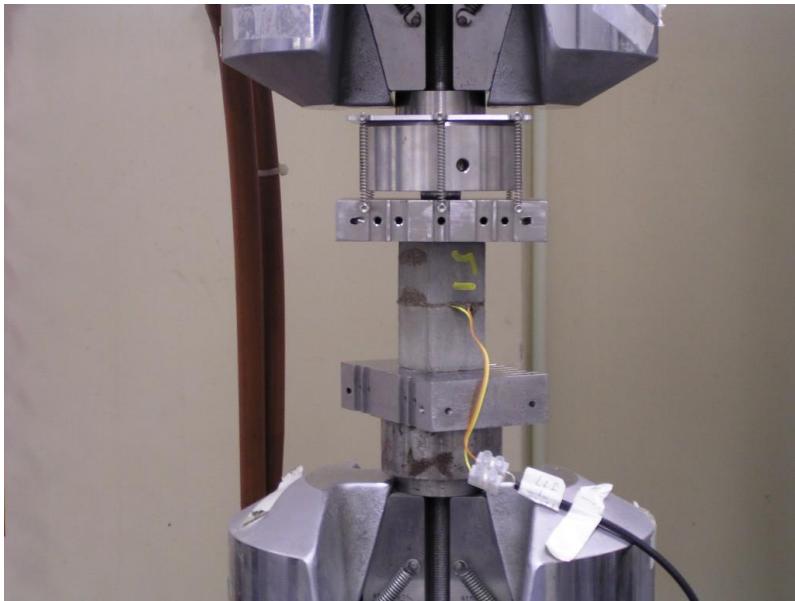
0-3 type of cement-based piezoelectric sensor



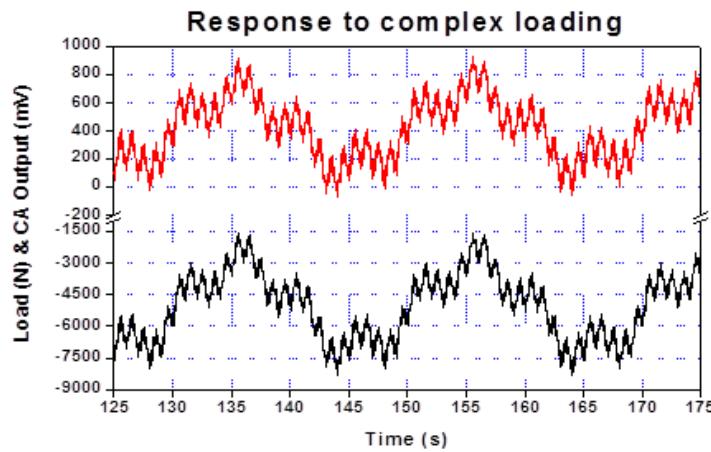
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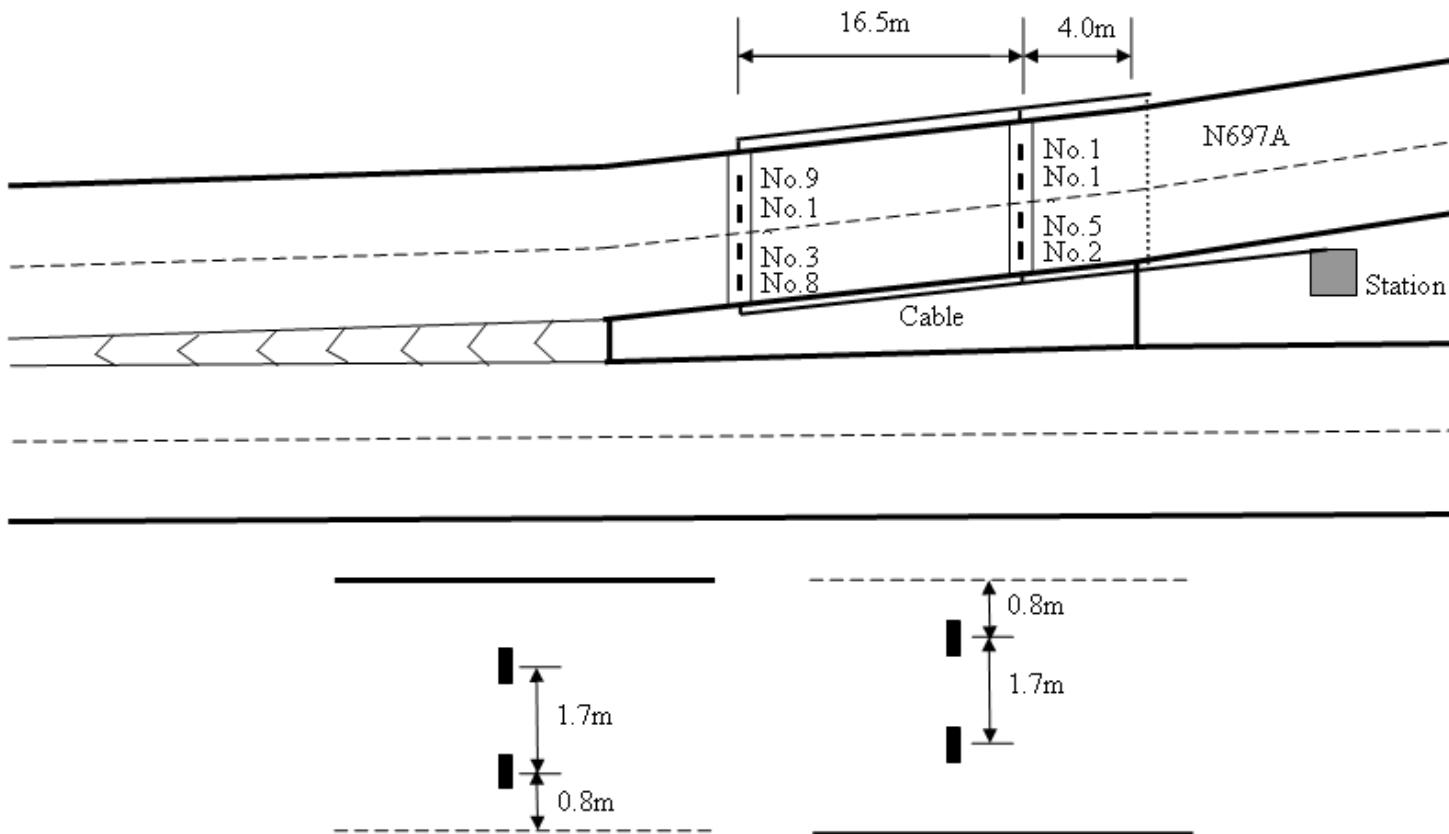
Measurement of sensing system



CA system (Kistler) – Fac3 in beam



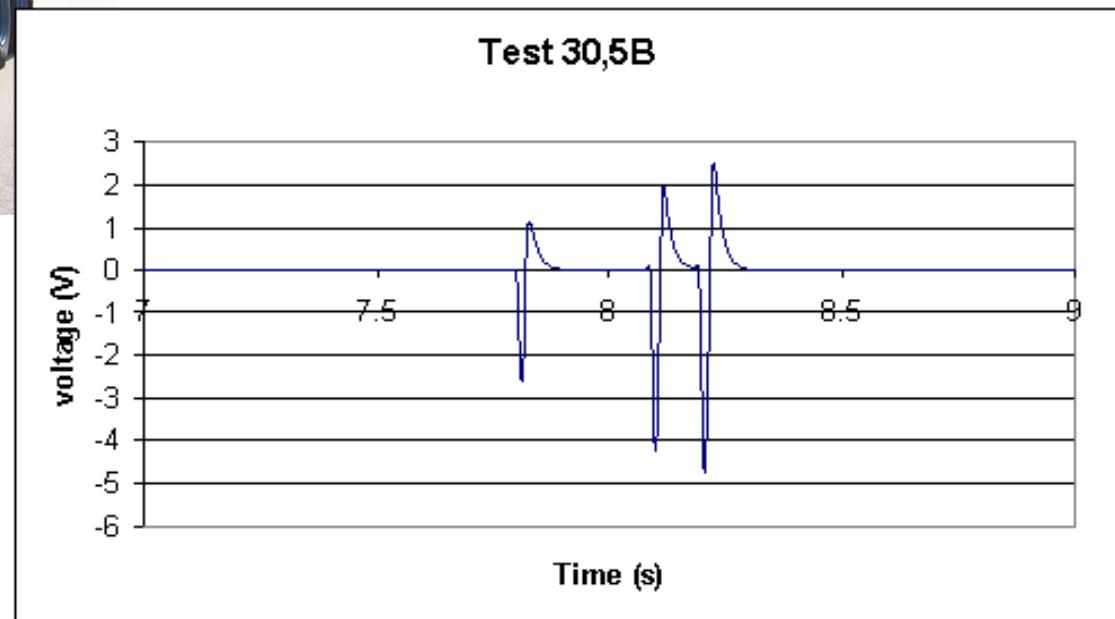
Field test on bridge N697A

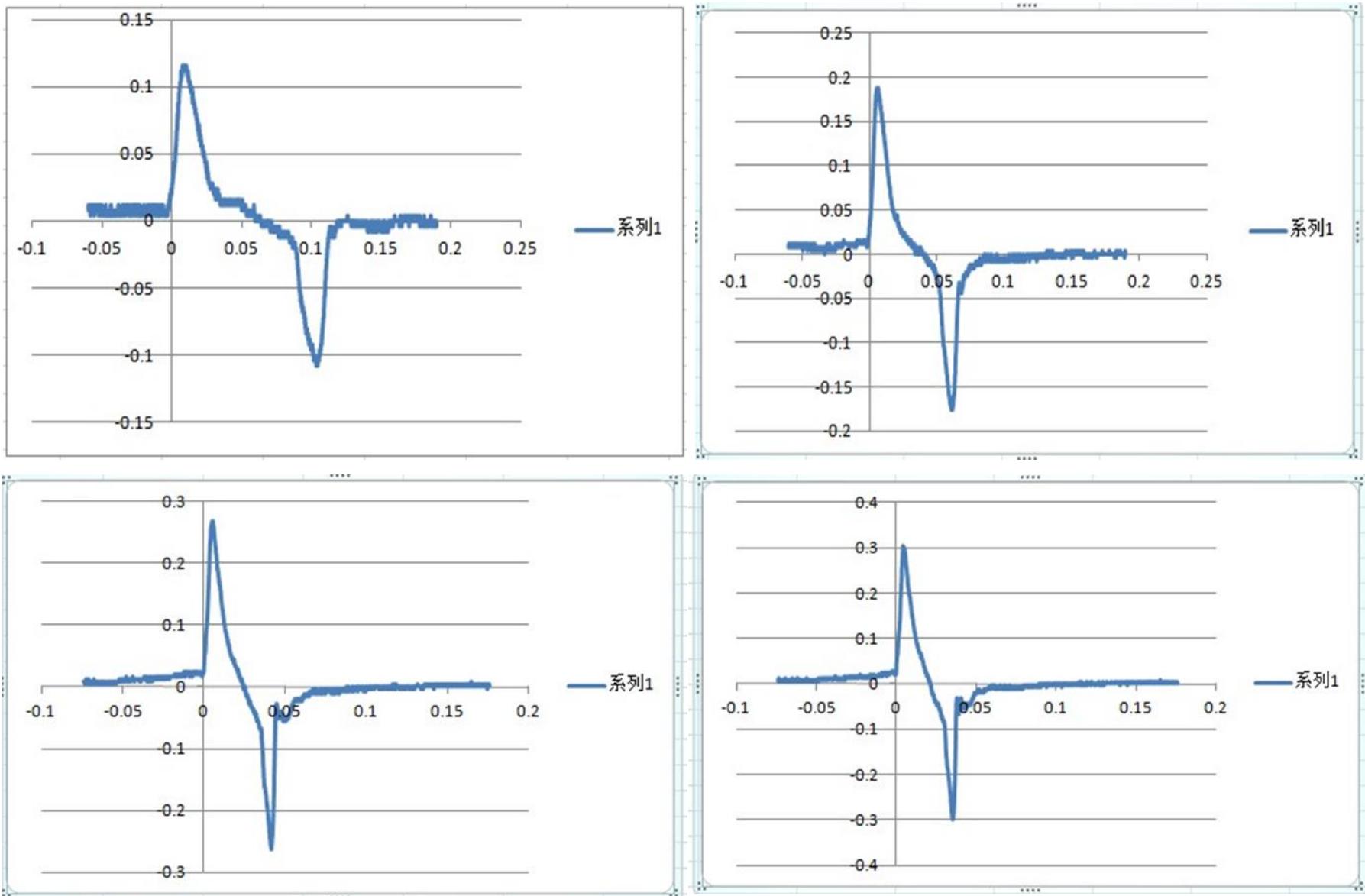


Installation on site



Response to passing truck





The oscilloscopes of 8 t middle bus driving through weighing beam at different speed







Dynamic modulus and Poisson's ratio

$$E = \rho C_L^2$$

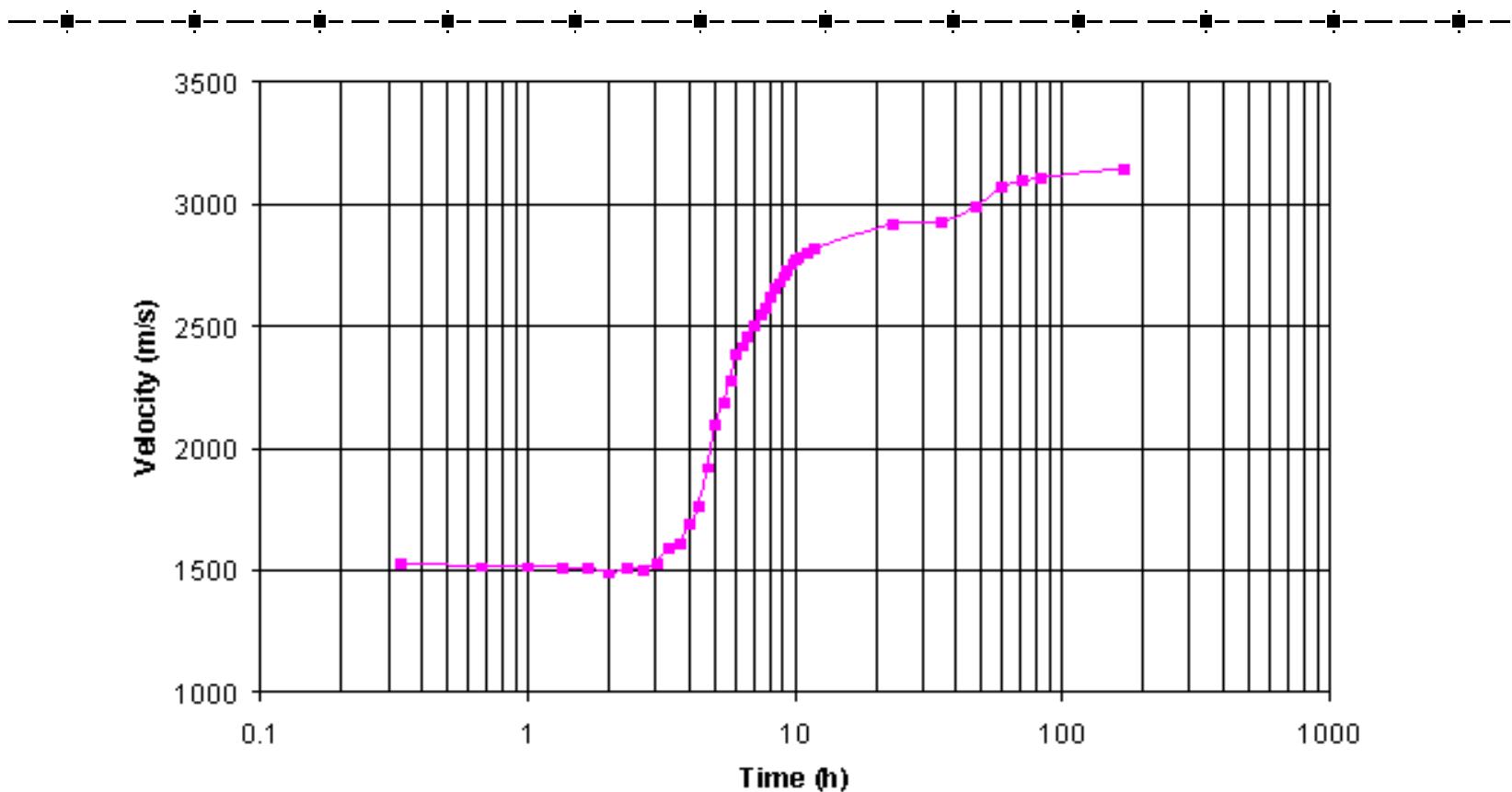
$$\nu = \frac{C_L^2}{2C_T^2} - 1$$

Where,

C_L and C_T are longitudinal and transverse velocities, respectively. ρ is the density of the concrete specimen.

The calculated result fit well with the dynamic Young' modular measured by standard method.

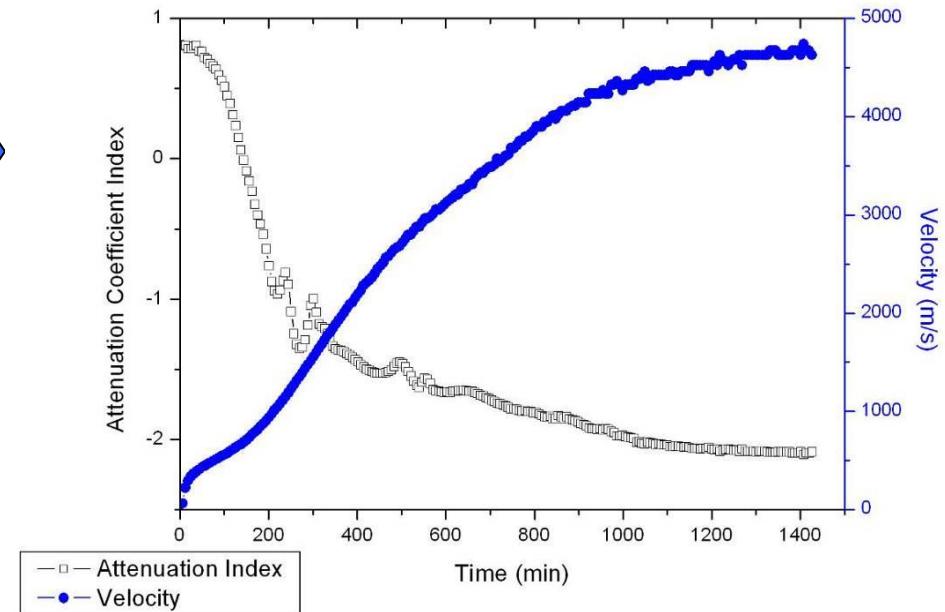
Hydration monitoring using embedded sensor



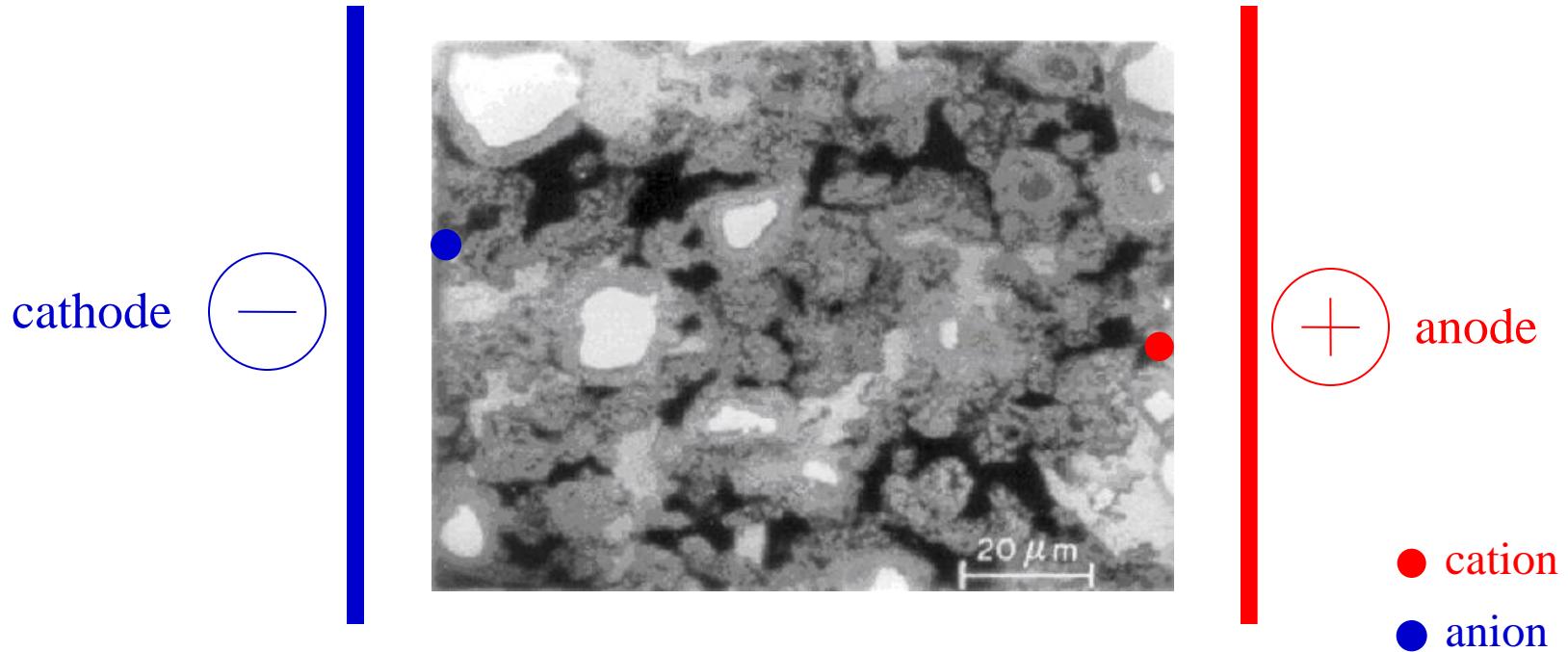
Hydration monitoring using embedded sensor



- ✓ In situ monitoring
- ✓ Life-time monitoring.



Cement conduction mechanism

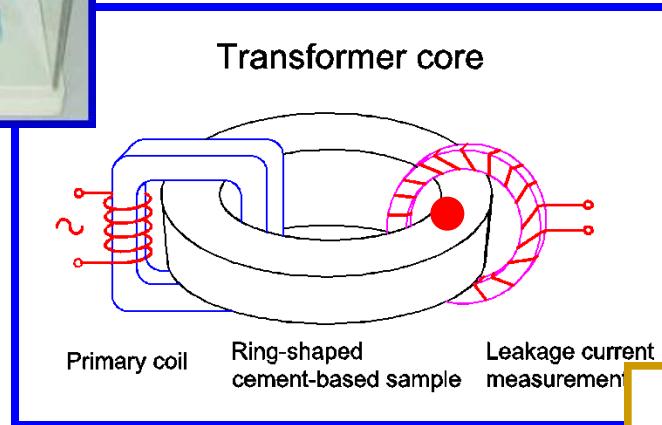


Conduction in cement is essentially electrolytic via ion transport through the interconnected pore network.

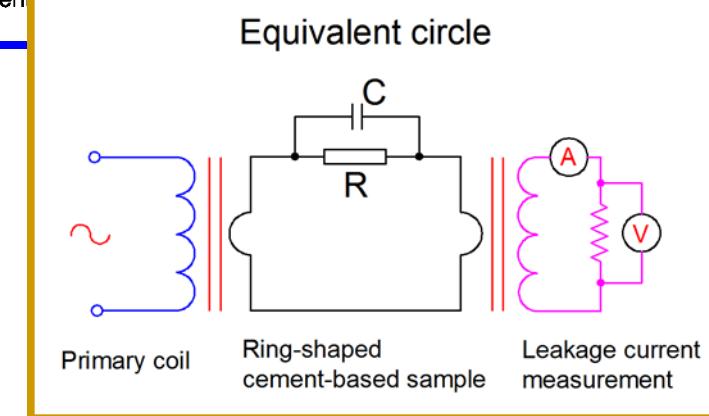
Non-contact resistivity measurement



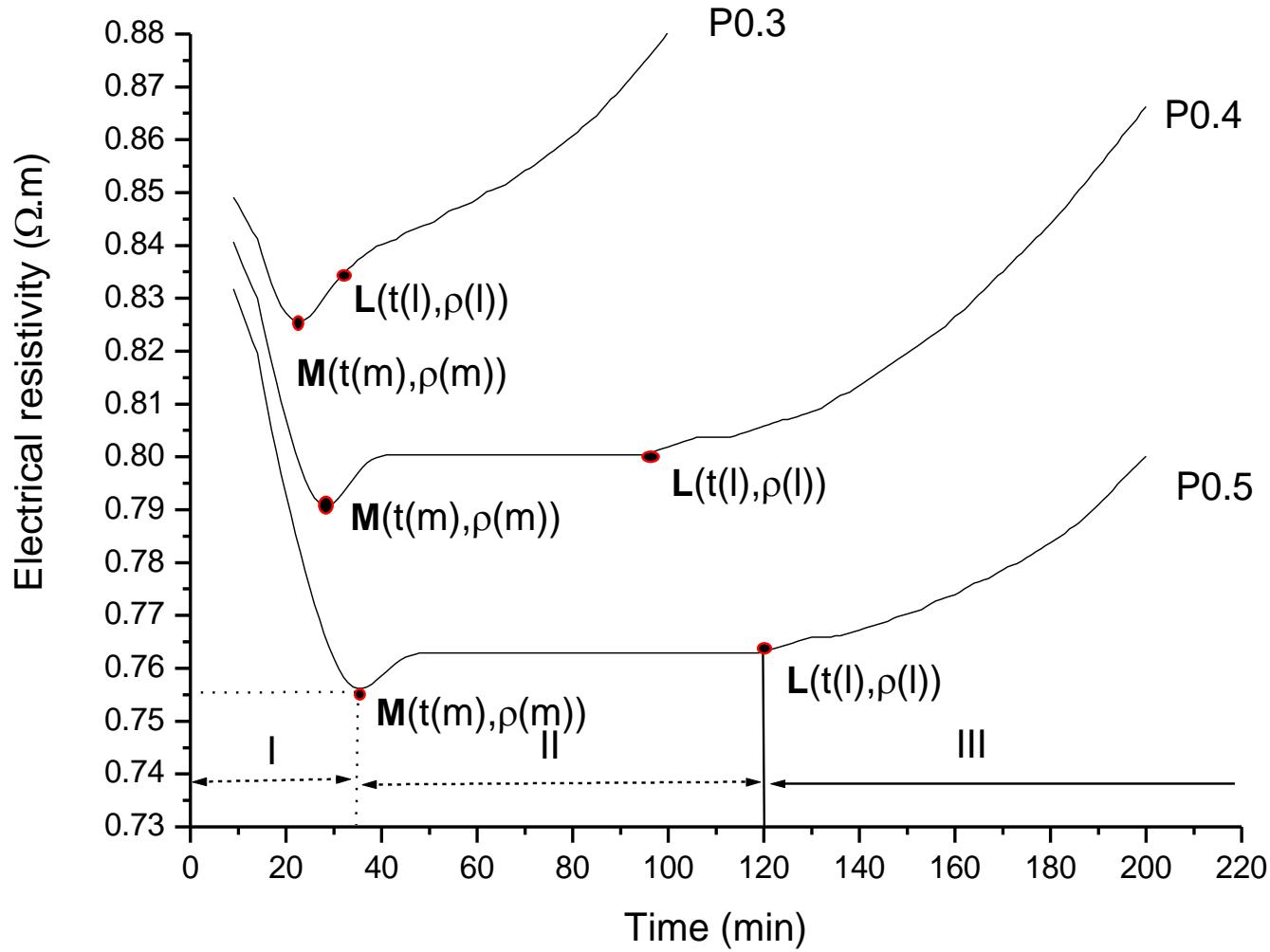
AC signal
1 KHz

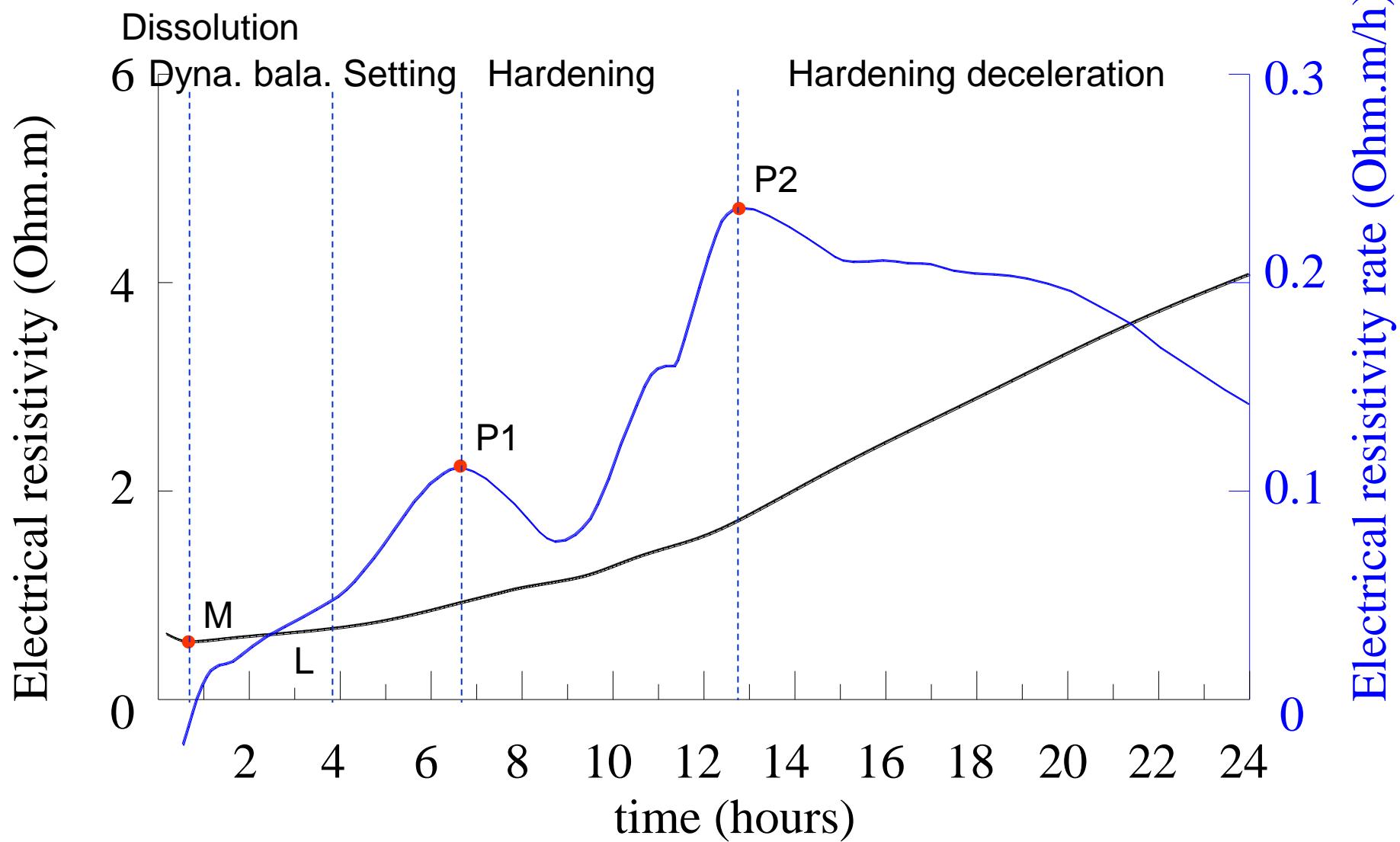


Works as a transformer
No electrode



Typical resistivity curve





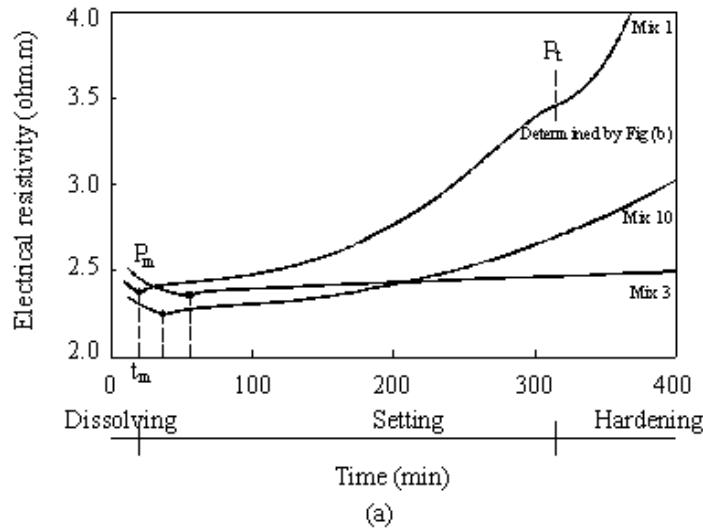
Penetration method for setting time



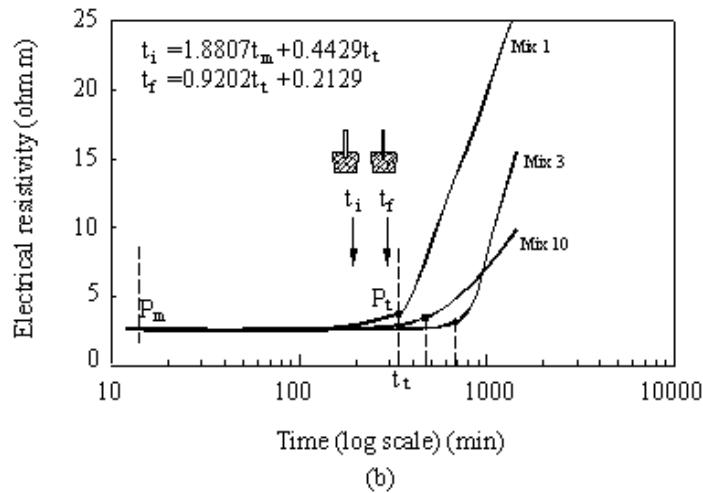
Initial setting:
Penetration resistance: 3.5 MPa

Final setting:
Penetration resistance: 28 MPa
(ASTM 403)

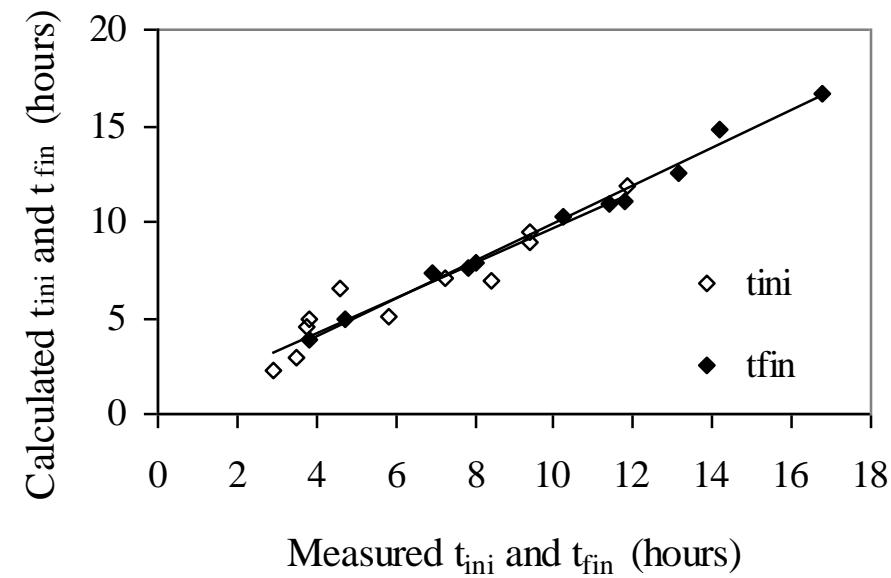
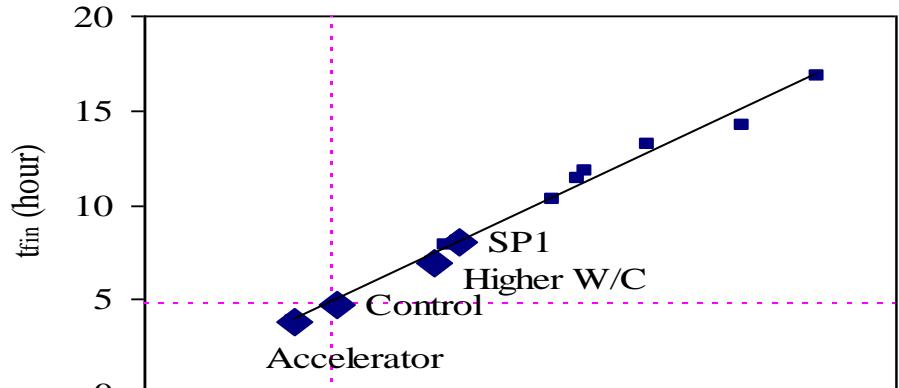
Concrete setting time



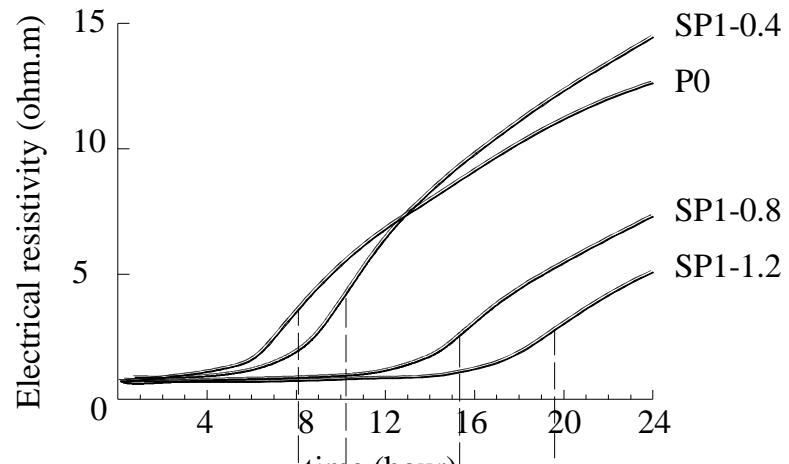
(a)



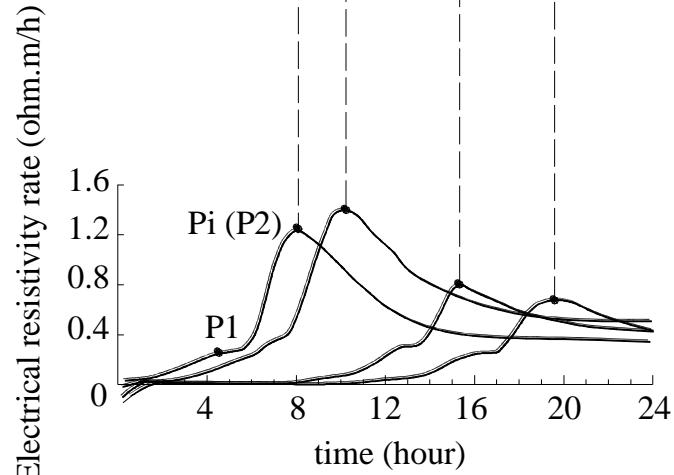
(b)



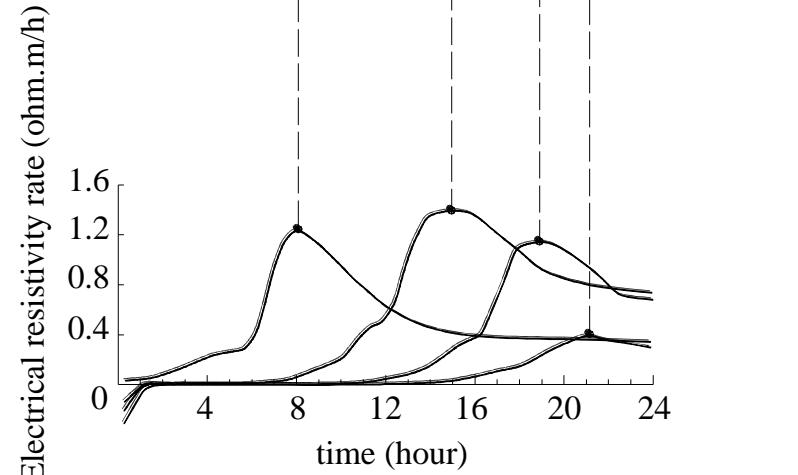
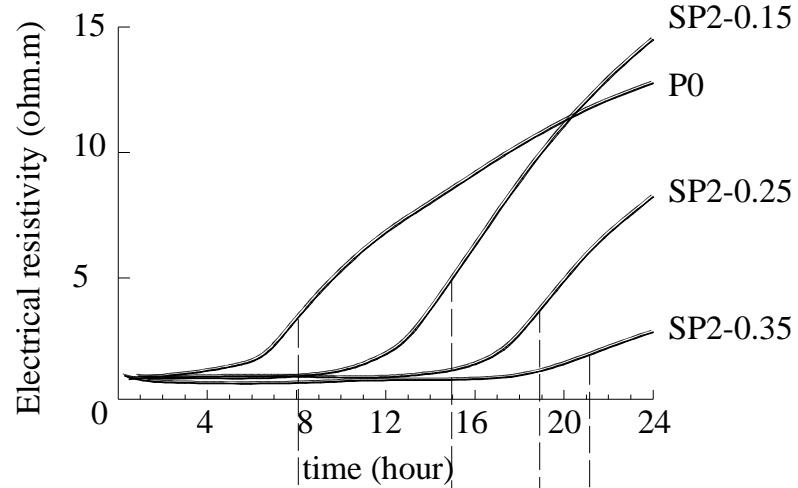
Compatibility between admixture and cement



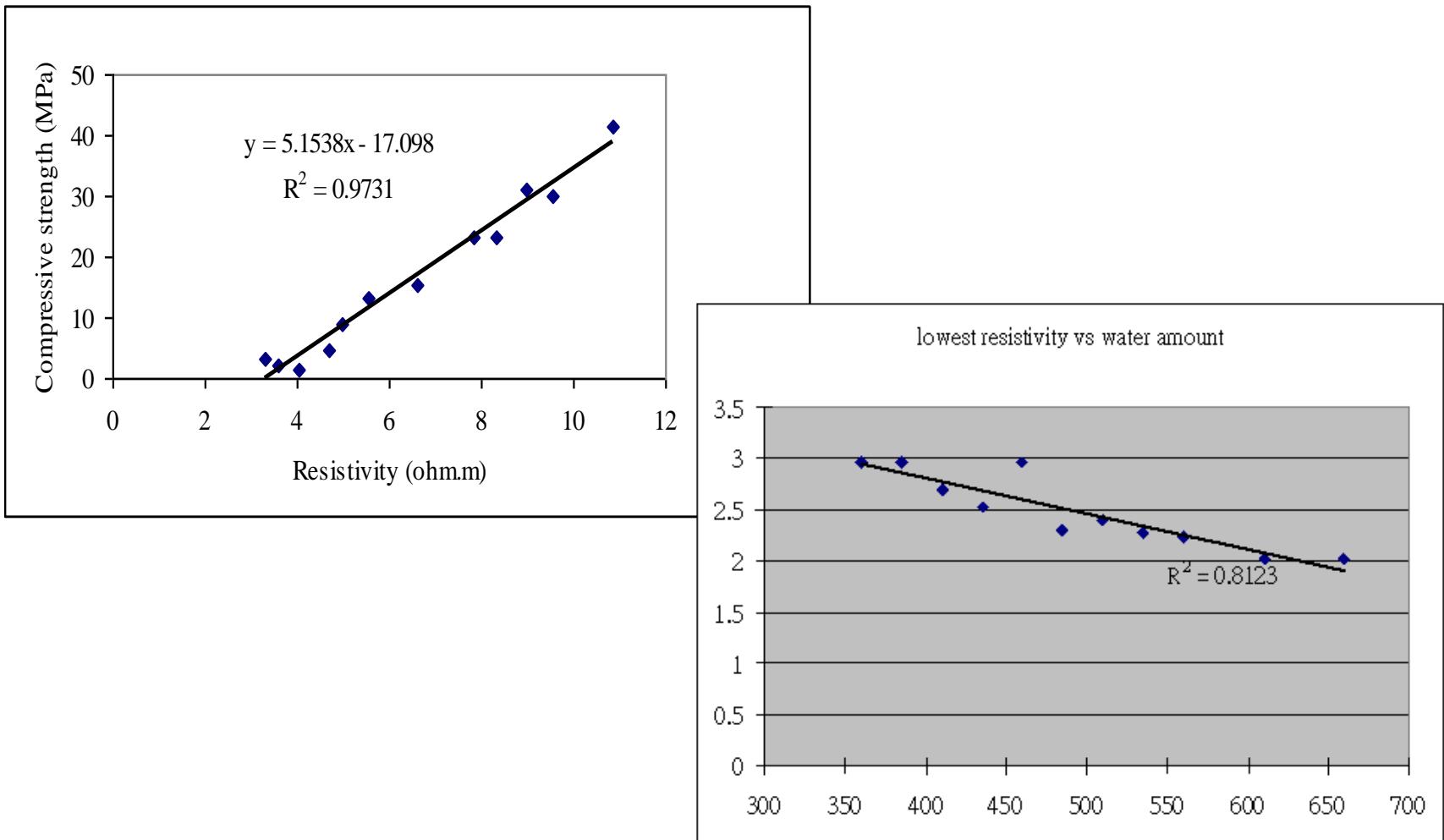
(a)



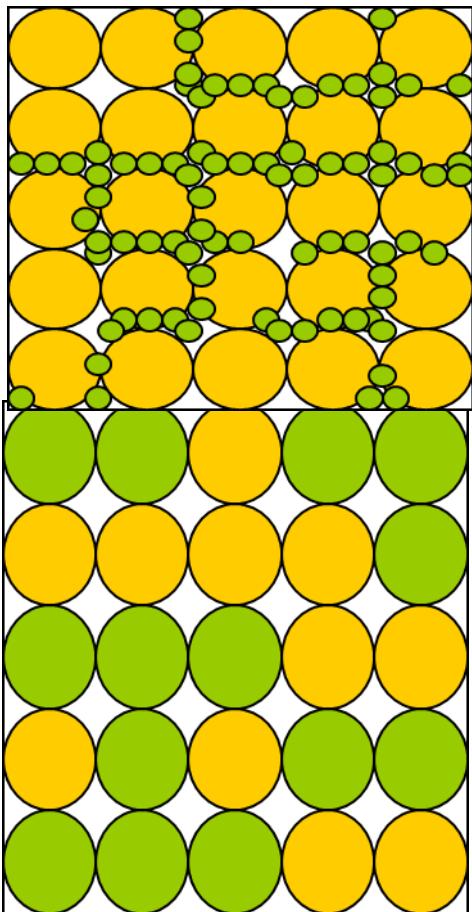
(b)



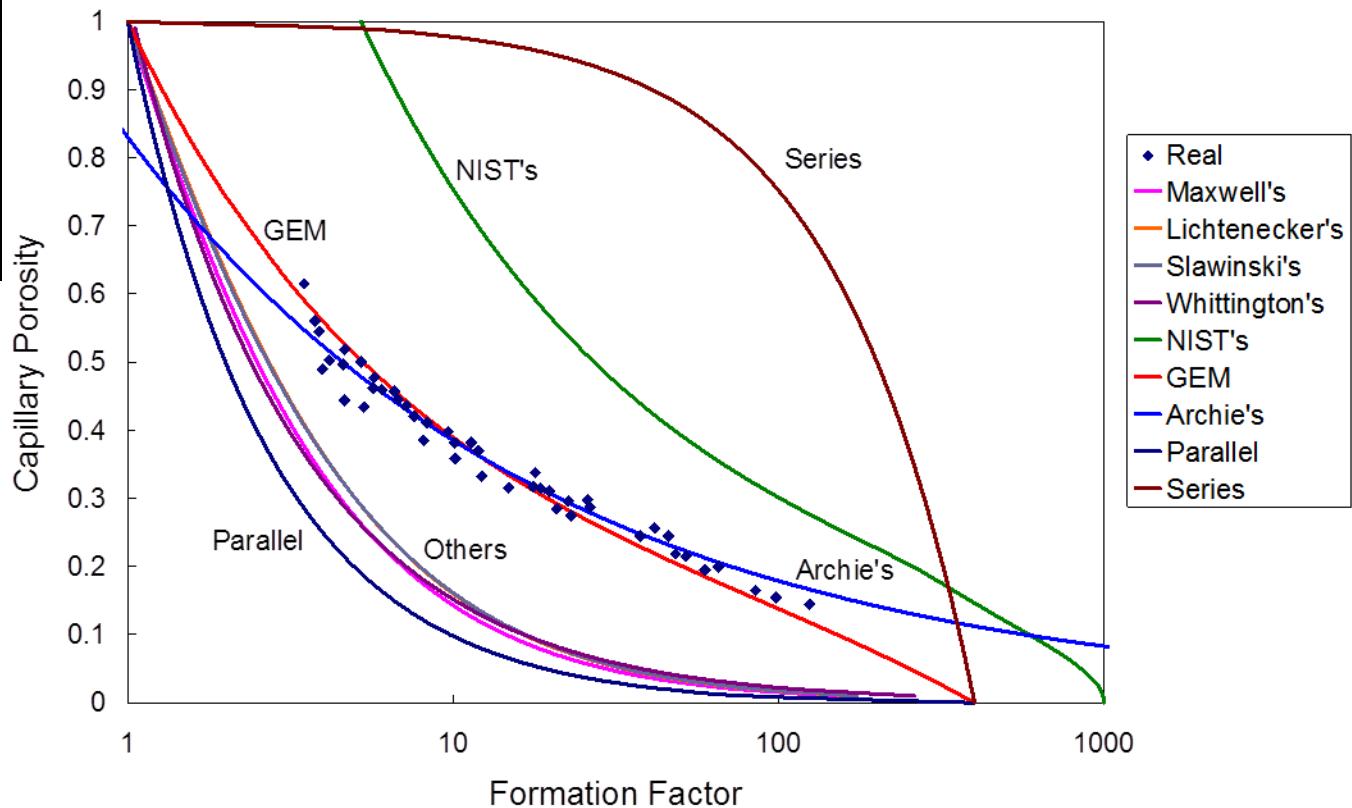
Predict strength and real water amount



New pore size assessment methods



$$\phi = \left[(1 - 0.18) F^{-1/2} + 0.18 \right] \cdot \left(\frac{400^{1/2} - F^{1/2}}{400^{1/2} - 1} \right)$$



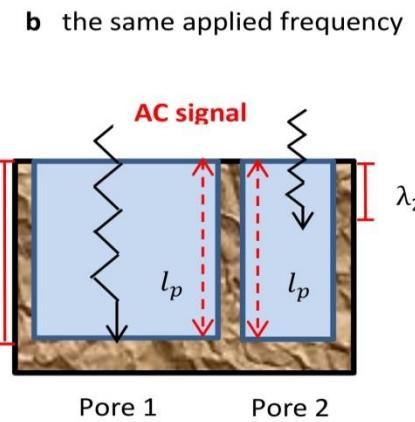
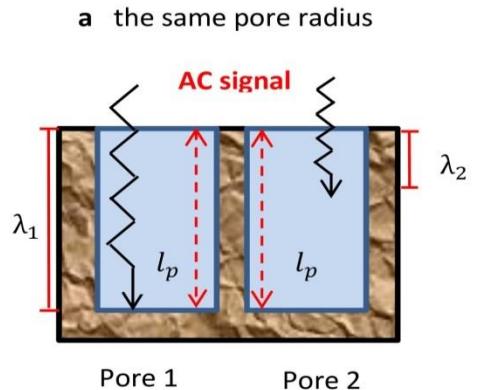
New pore size assessment methods

$$\frac{l_p^2}{d} \leq \frac{1}{8\rho_0\delta\omega}$$

d is diameter of pore (m)

ρ_0 is the pore solution resistivity ($\Omega \cdot \text{m}$)

δ is the specific electrical double layer capacitance at the interface ($\text{F} \cdot \text{m}^{-2}$)
 ω is angular frequency ($\text{rad} \cdot \text{s}^{-1}$)



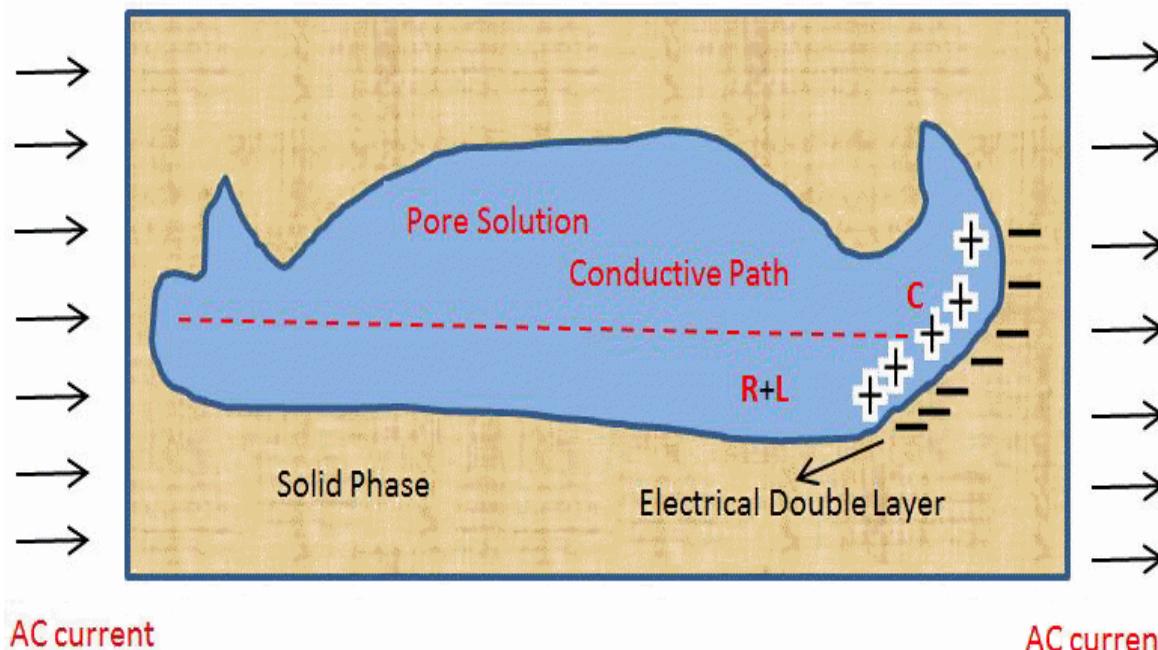
New pore size assessment methods

Three kinds of components in one conductive path:

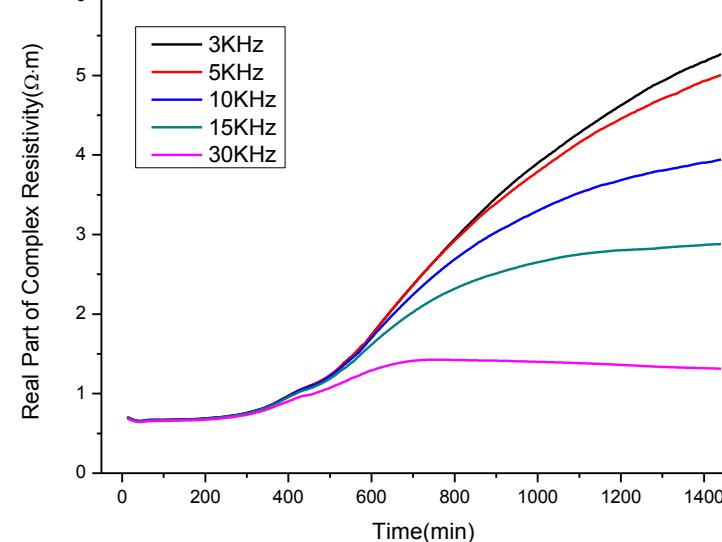
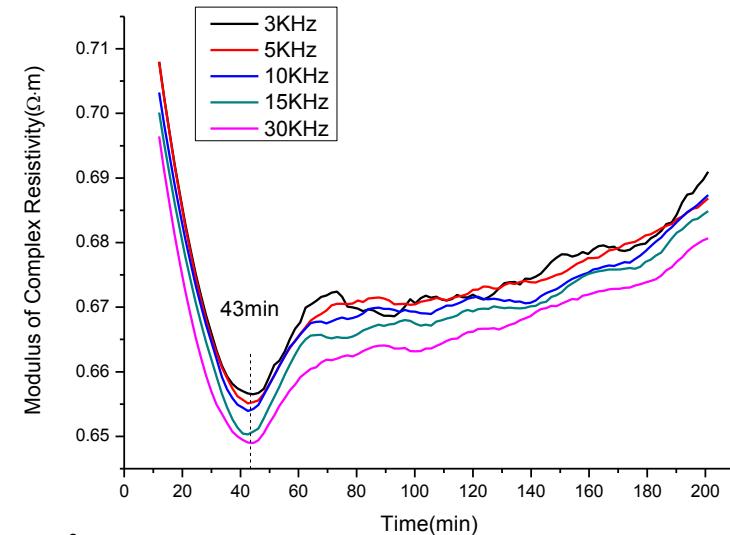
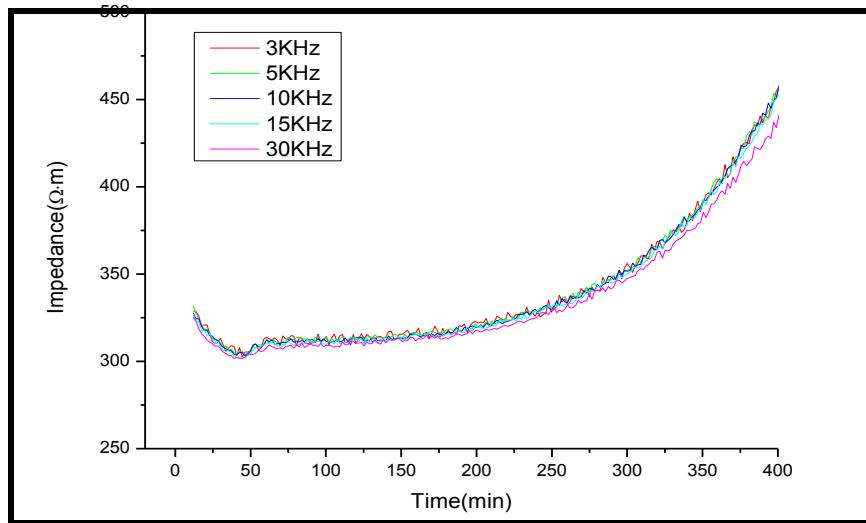
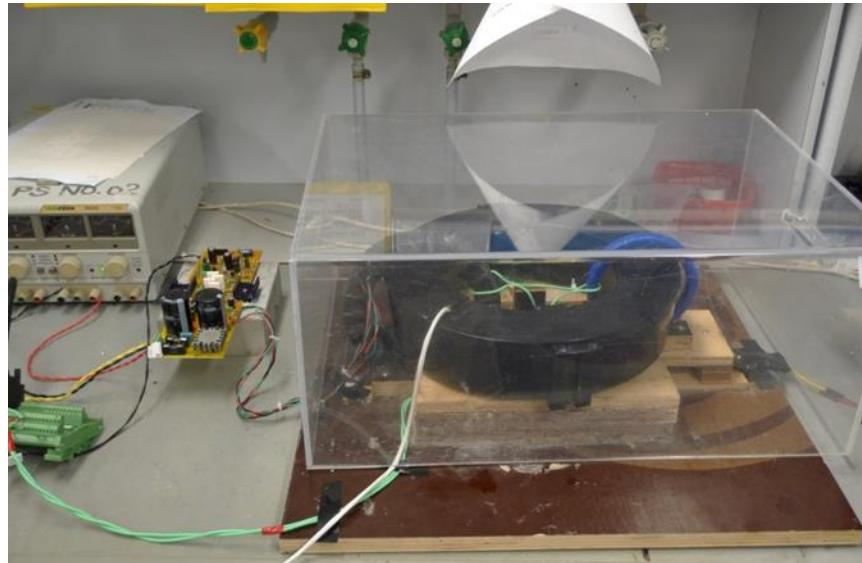
R---Resistance of pore solution

L----Inductance of the conductive path due to the tortuosity

C----Interfacial capacitance between the solid and liquid phases

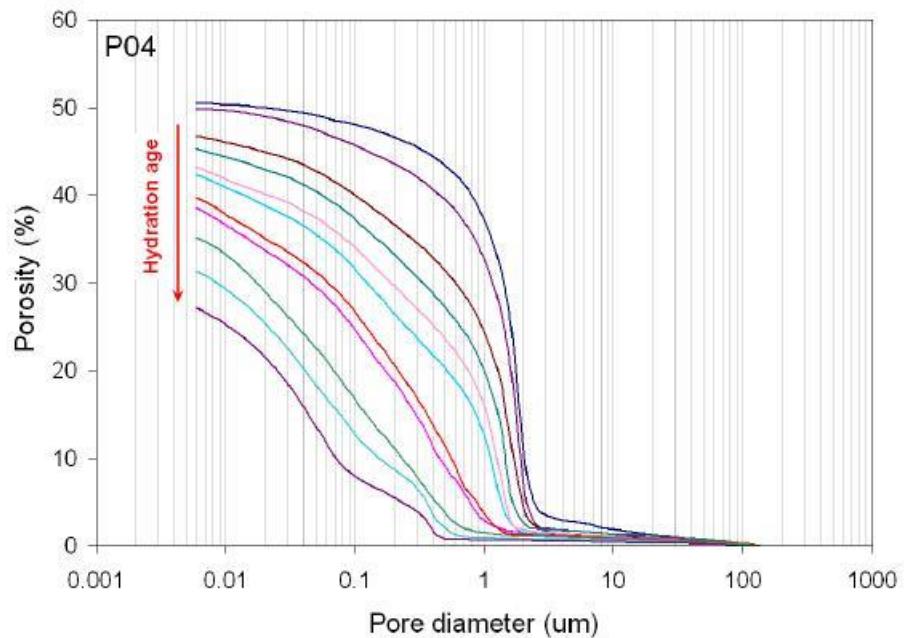
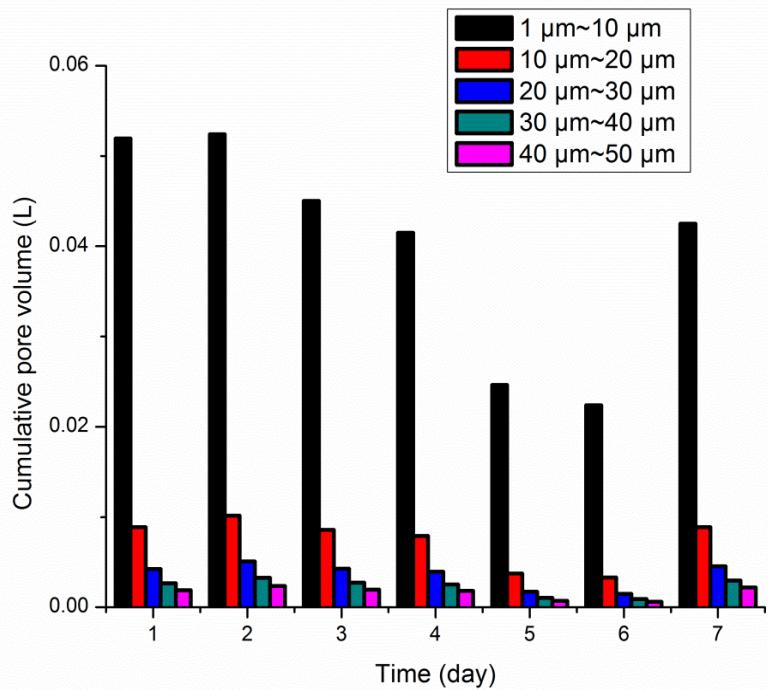


New pore size assessment methods



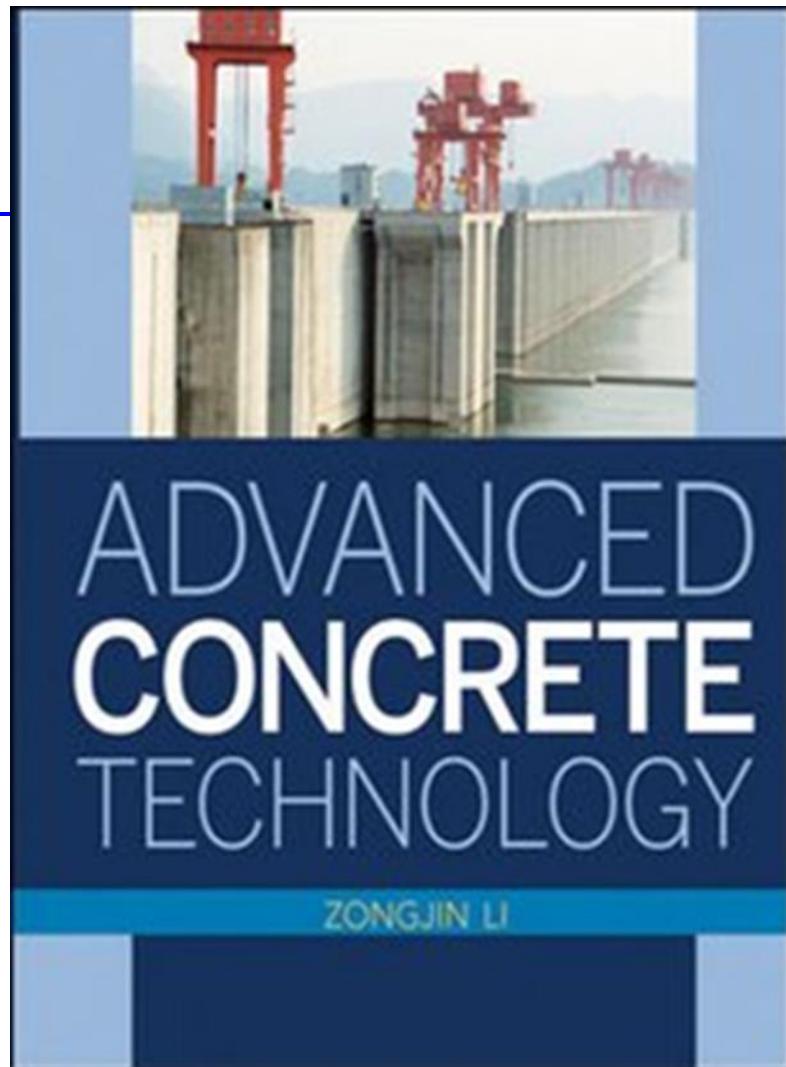
New pore size assessment methods

w/c=0.5



Same Trend with MIP :

- 1.The cumulative pore volume decreases with hydration time.
- 2.Small pore clusters always occupy large pore volume



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Thank you for your attention !

