Durability - 100 years!

Great Belt, Denmark (1998)

Span: 1624 m

Akashi Kaikyo, Japan (1998)

Span: 1991 m

Identification of Microcracks caused by Autogenous Shrinkage

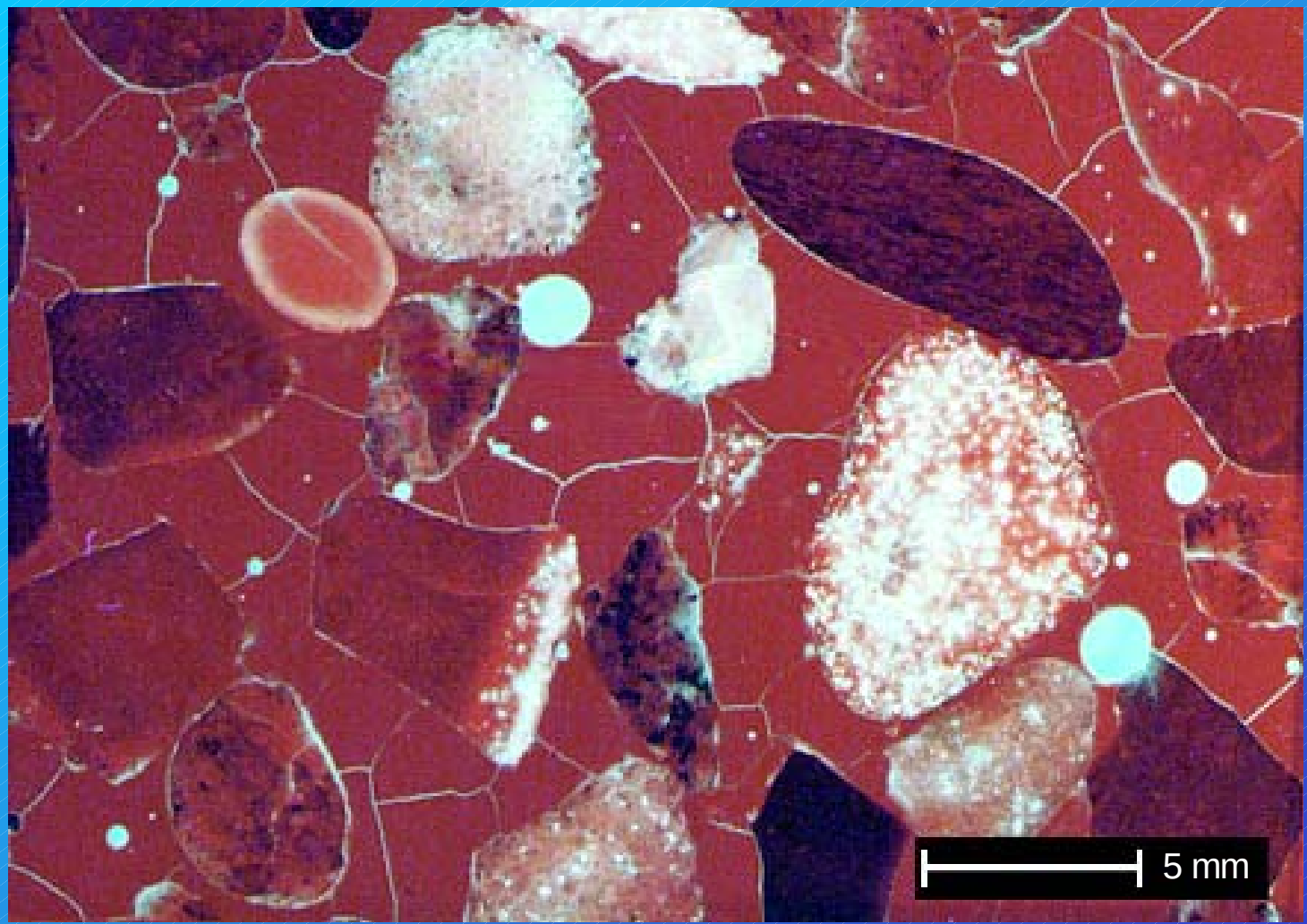
Pietro Lura,
Ye Guang, Kyoji Tanaka,
and Ole Mejlhede Jensen

DTU

Early-age cracking

Tokyo Institute of Technology, Yokohama, Japan

Internal microcracking

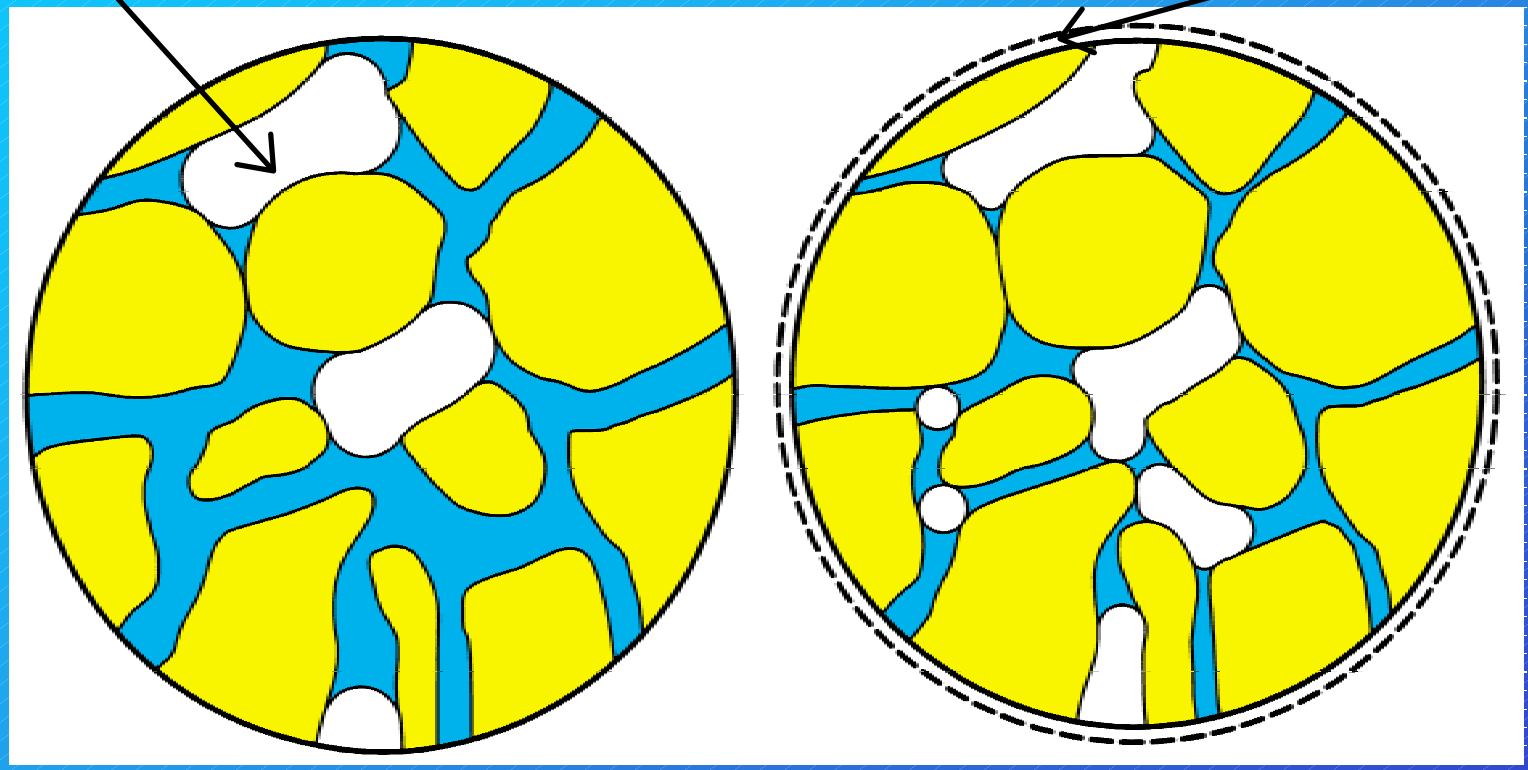


(Dela & Stang 2001)

Definitions

Chemical shrinkage

Autogenous shrinkage



solid

water

air

(Jensen 1993)

Autogenous shrinkage in HPC

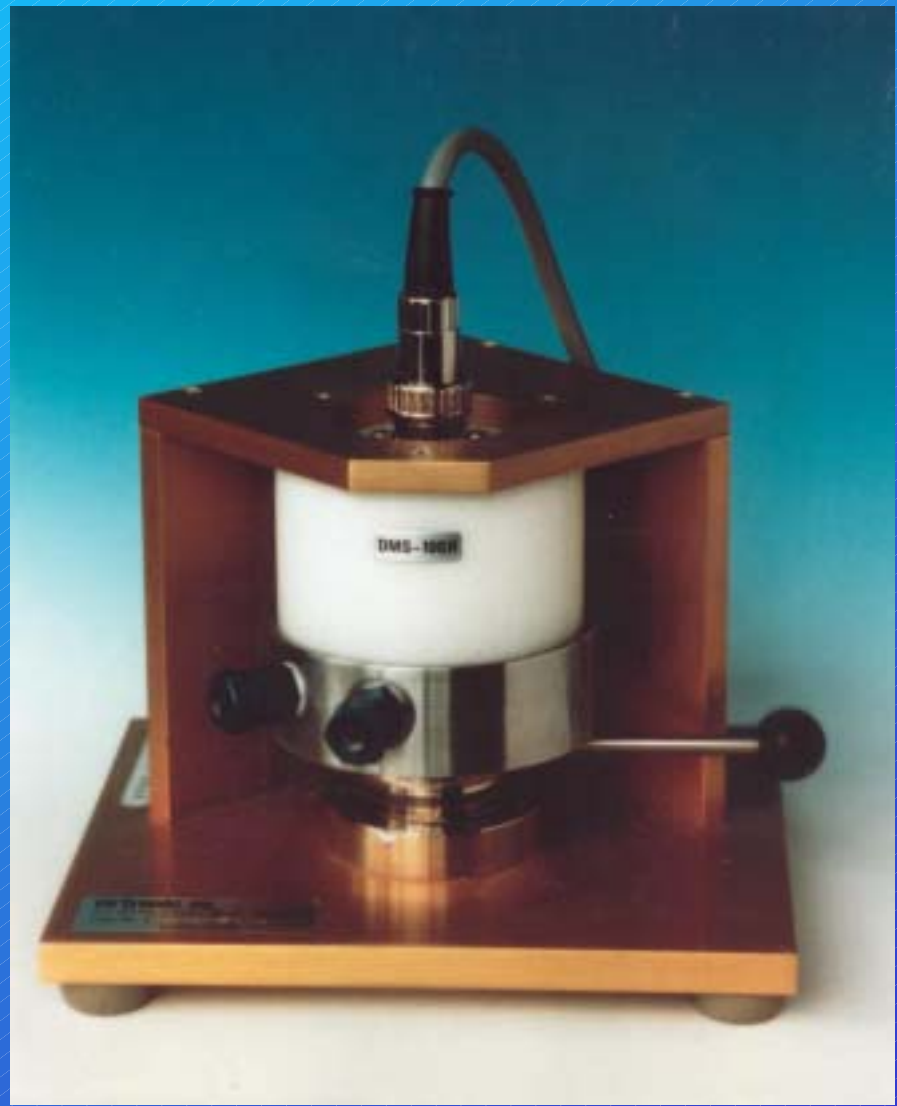
- Low w/c
- Silica fume
- (Dense aggregate)

Internal microcracking

- Does autogenous shrinkage lead to internal cracks?
- How to detect them?

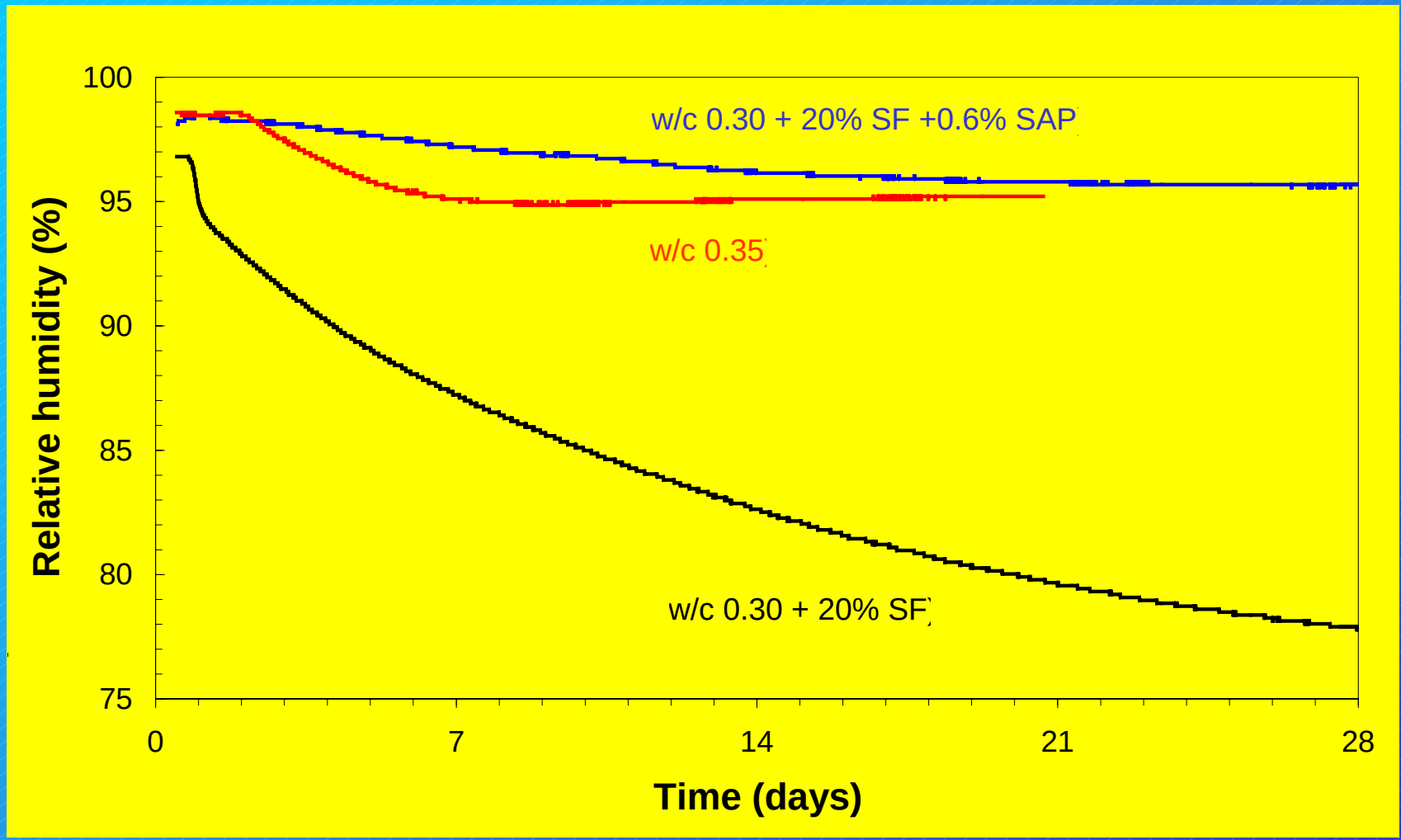
Autogenous relative humidity

Rotronic Hygroscop DT

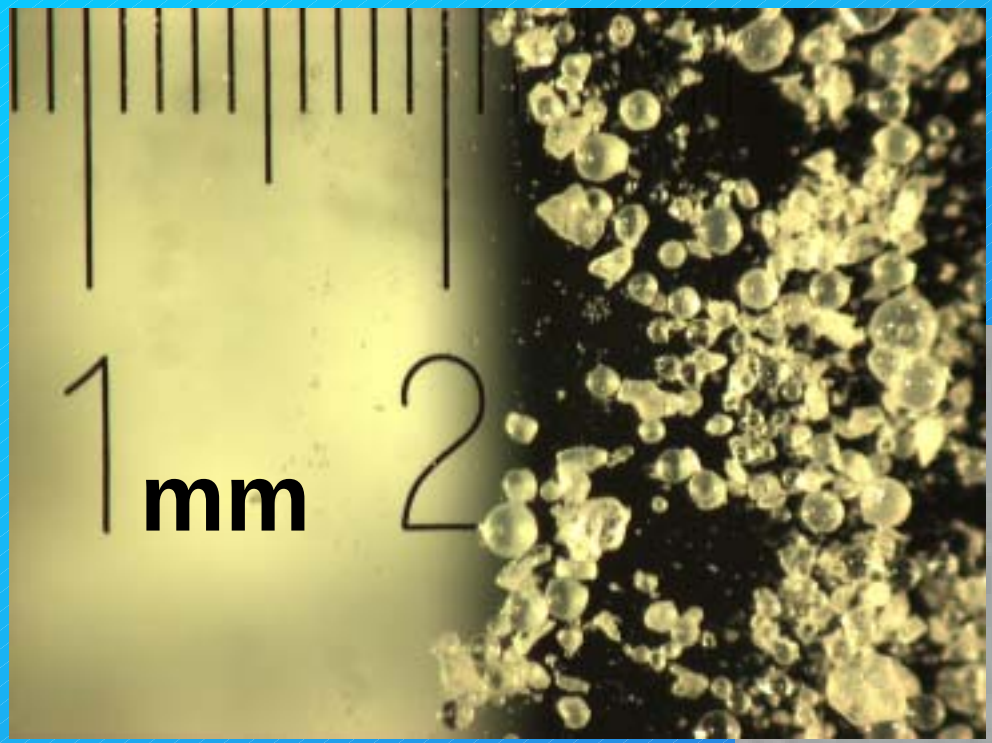


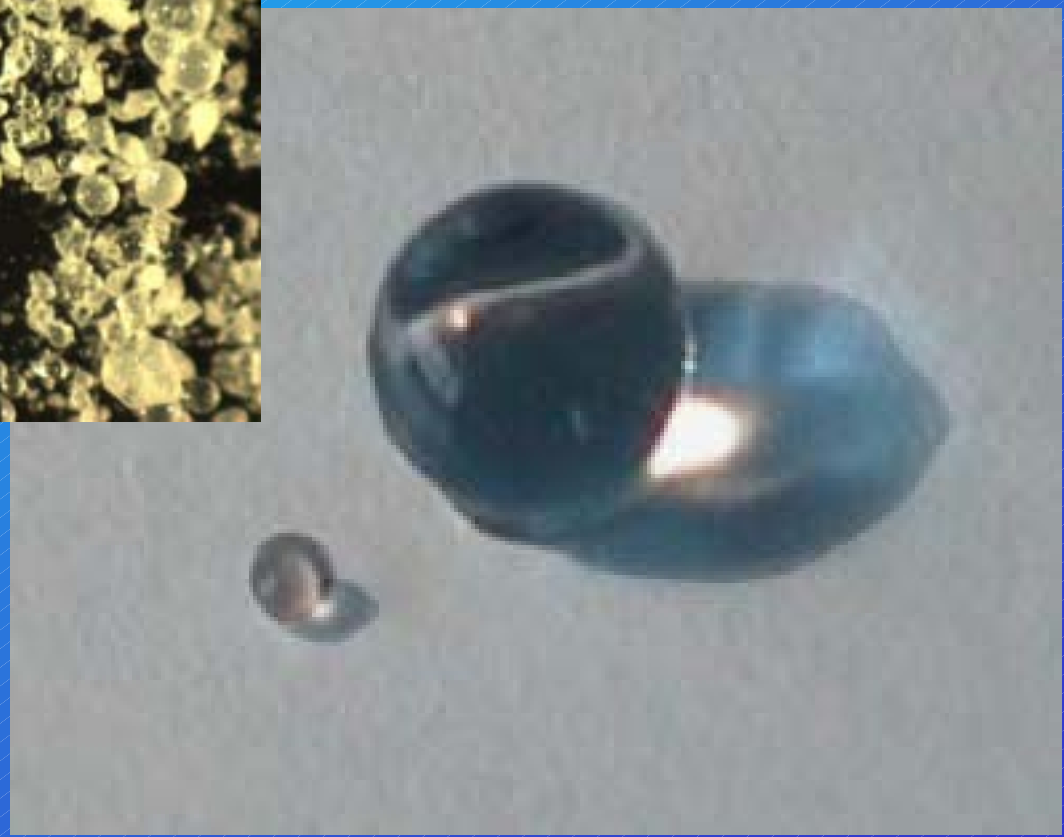
(Jensen & Hansen 1988)

Autogenous relative humidity



Superabsorbent polymers - SAP

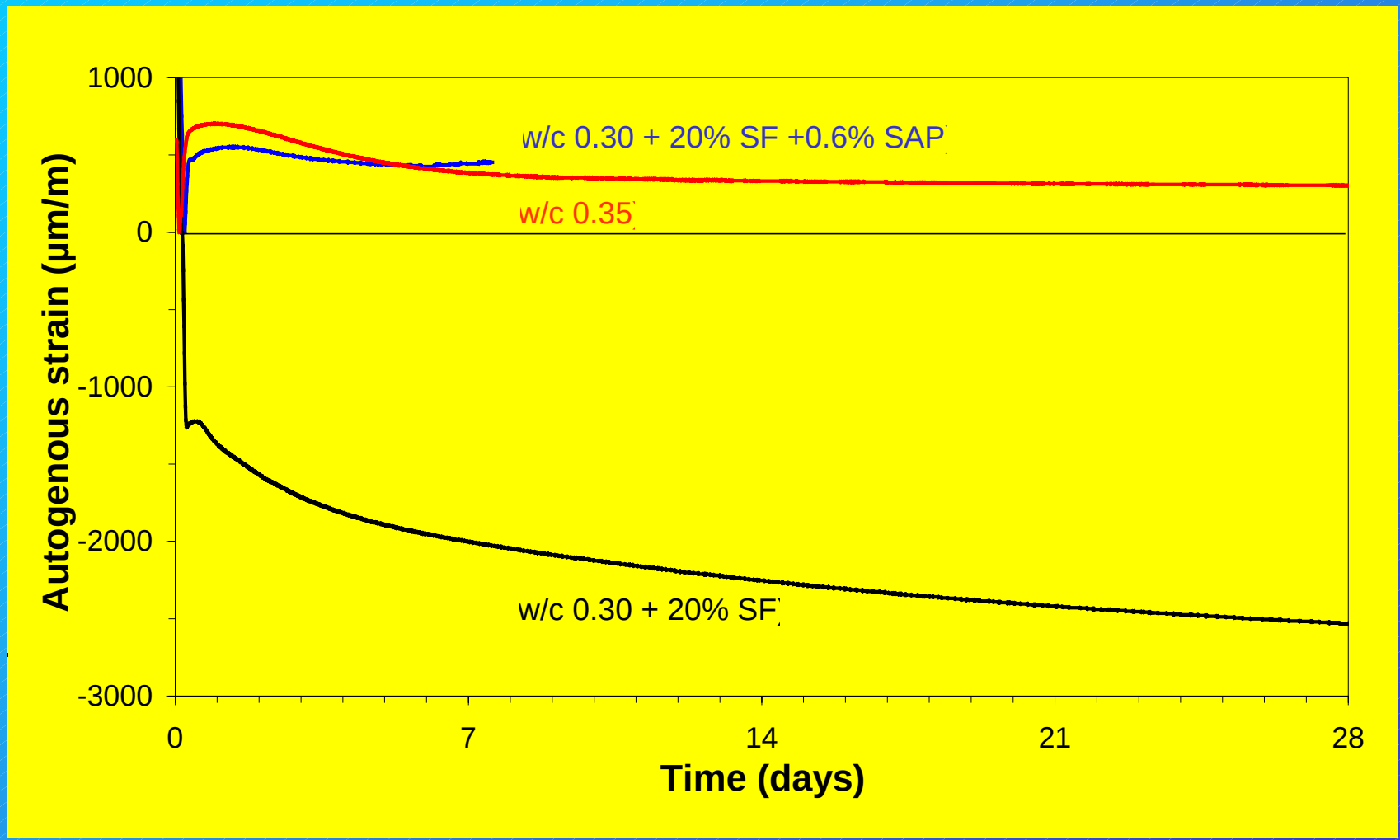




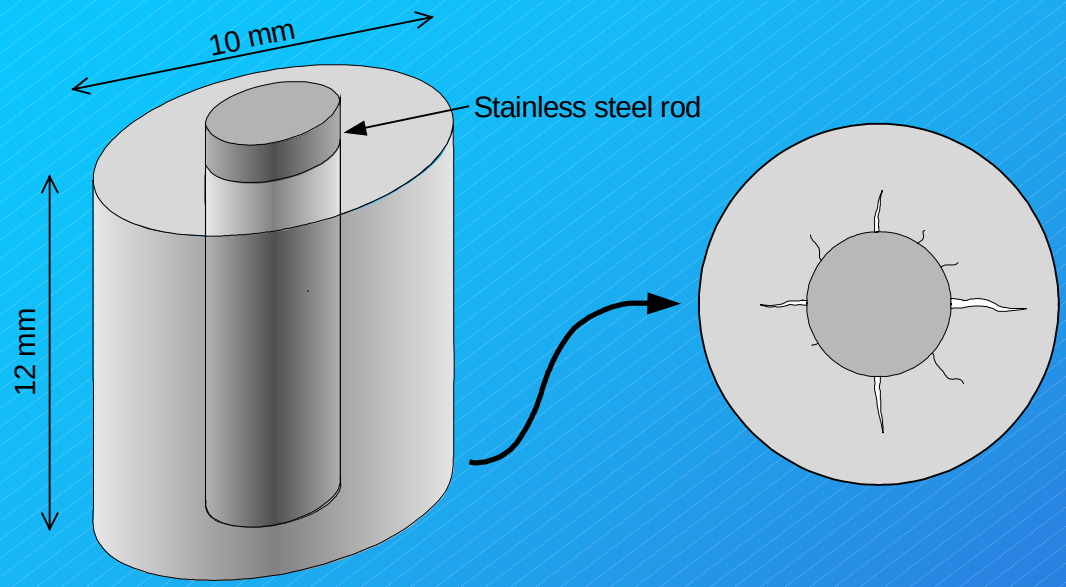
Autogenous strain – linear technique

Corrugated moulds

Autogenous strain

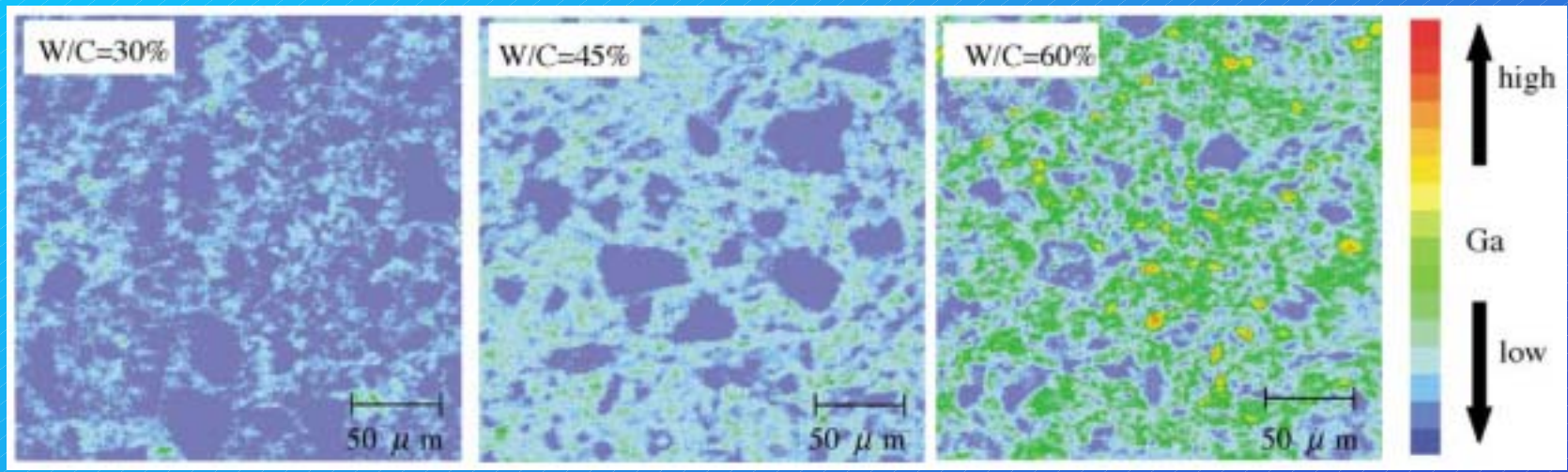


Samples for crack detection



- 3 cement pastes
- 0, 1.5, 3, and 6-mm rods
- 1 month sealed at 32°C

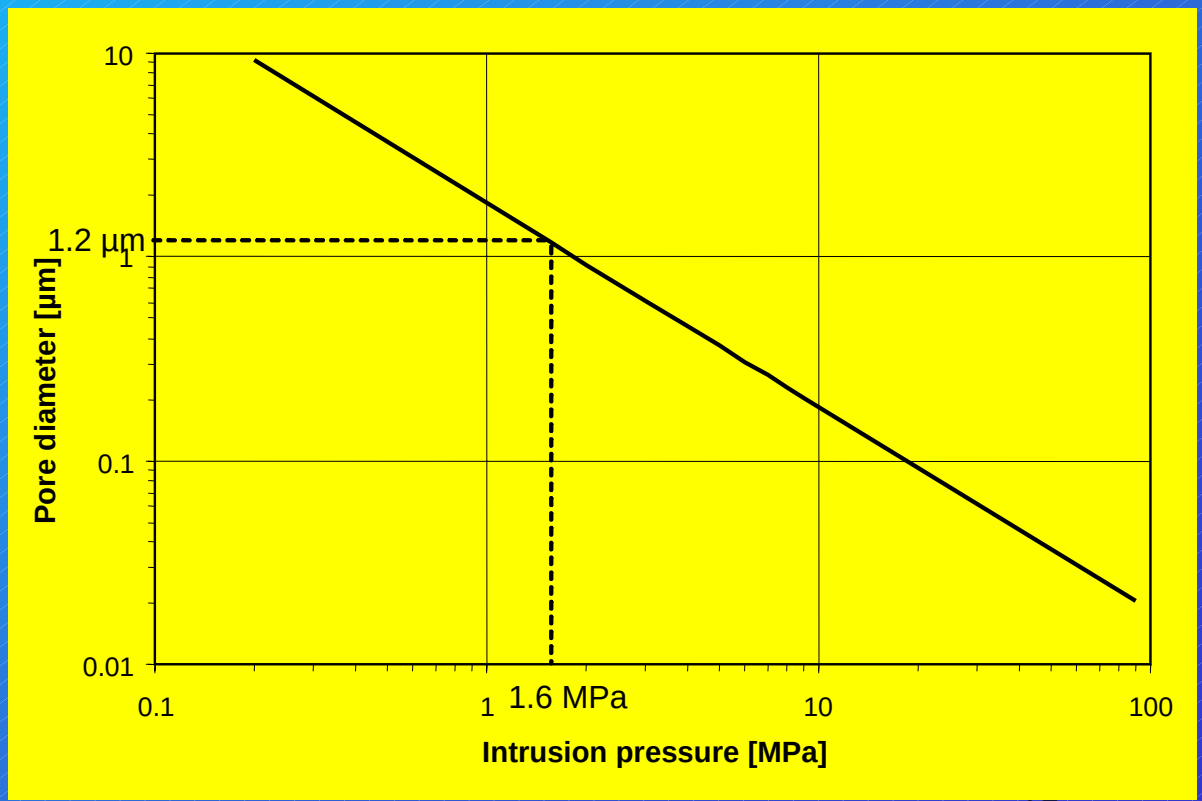
Gallium impregnated cement pastes



(Tanaka & Kurumisawa 2002)

Properties of Gallium

- melting point 29.8 °C
- does not wet cement paste
- nontoxic

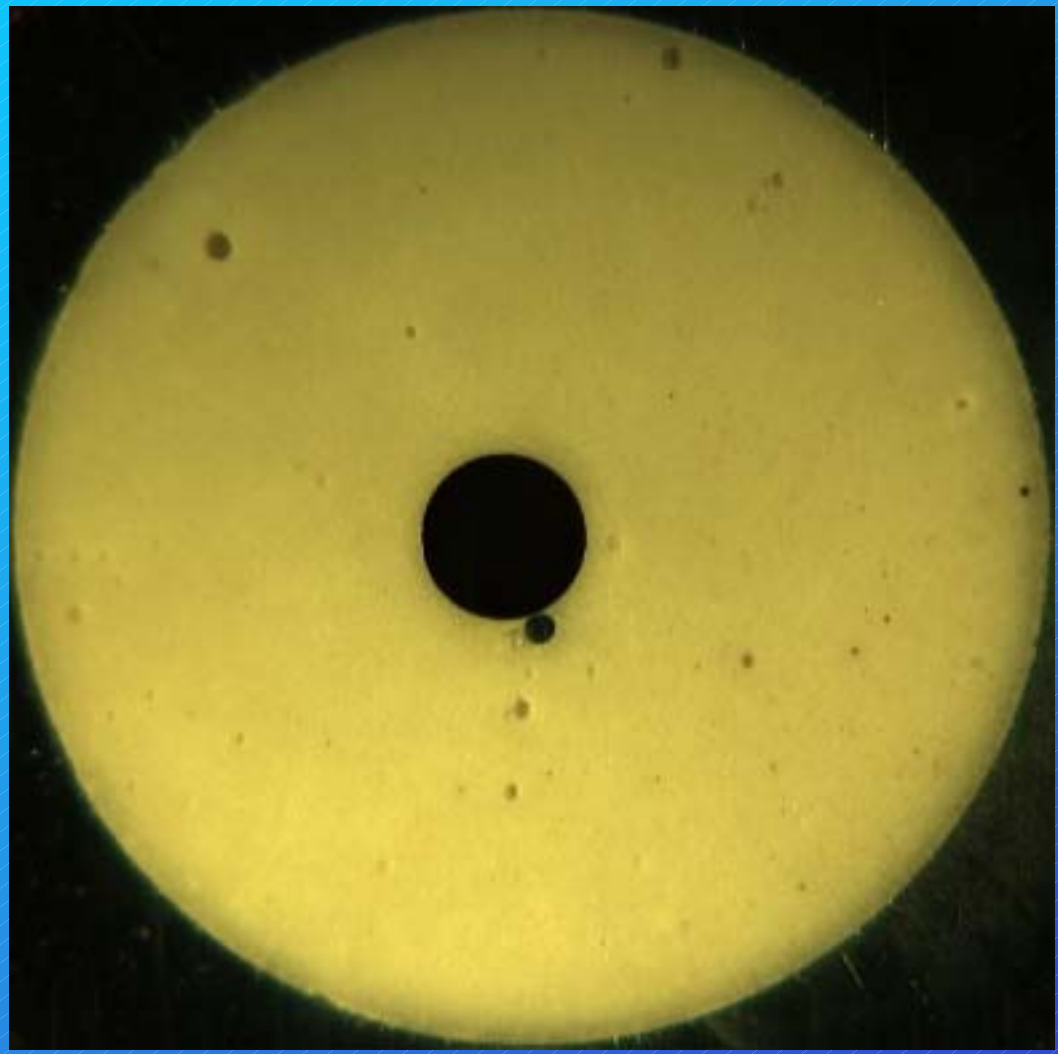


Gallium intrusion

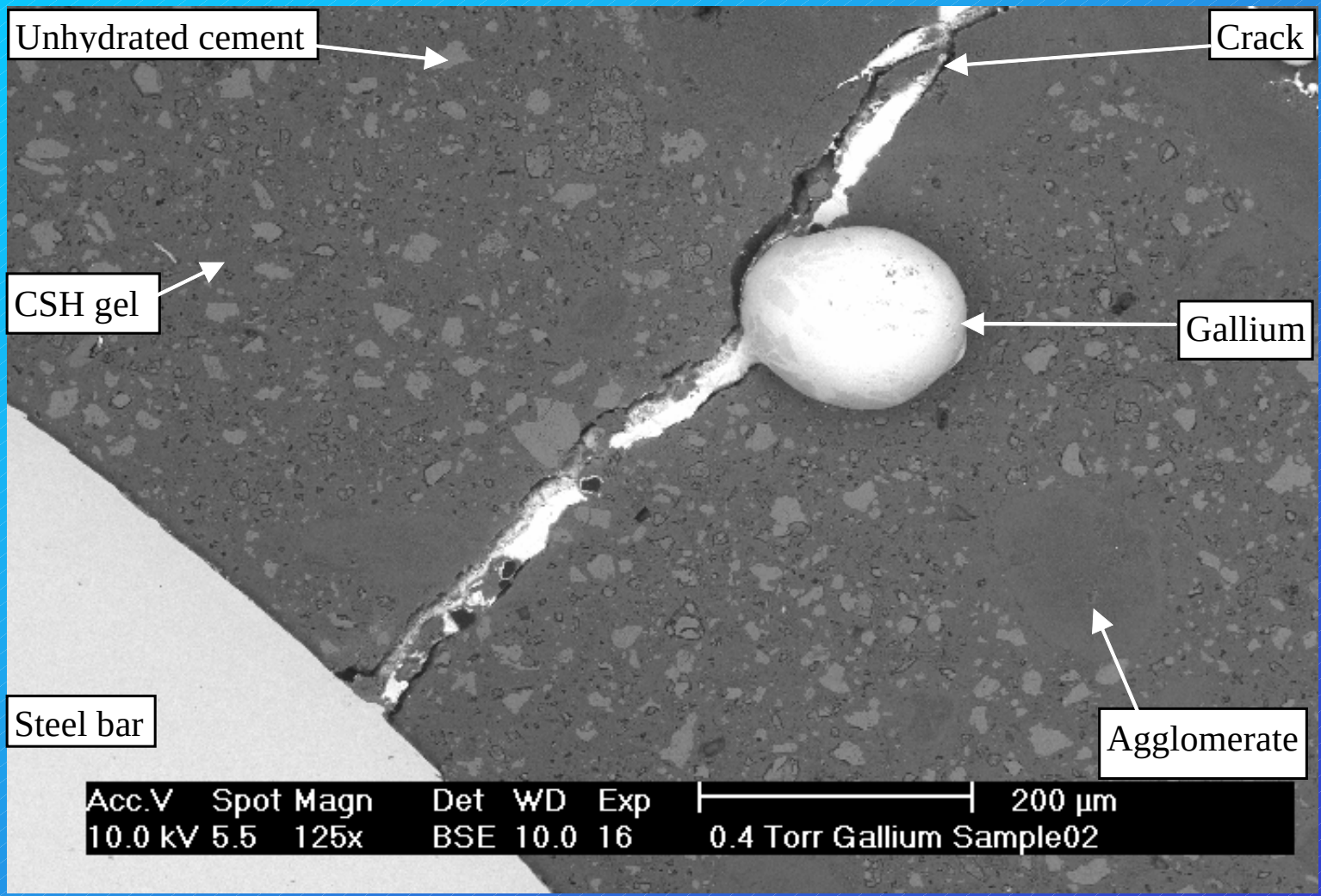
Sample preparation

- epoxy resin
- grinding
- polishing
- crack examination: - **optical microscope**
  - BSE
  - EPMA

Crack detection – OM



Crack detection - BSE



Conclusions

- Cracks before intrusion can be distinguished
- BSE useful for crack identification
- High shrinkage, big rod $\Rightarrow$ Cracks

Further research

- More experiments!
- Acoustic Emission
- FE calculations