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Concrete Research by Neutron Radiography

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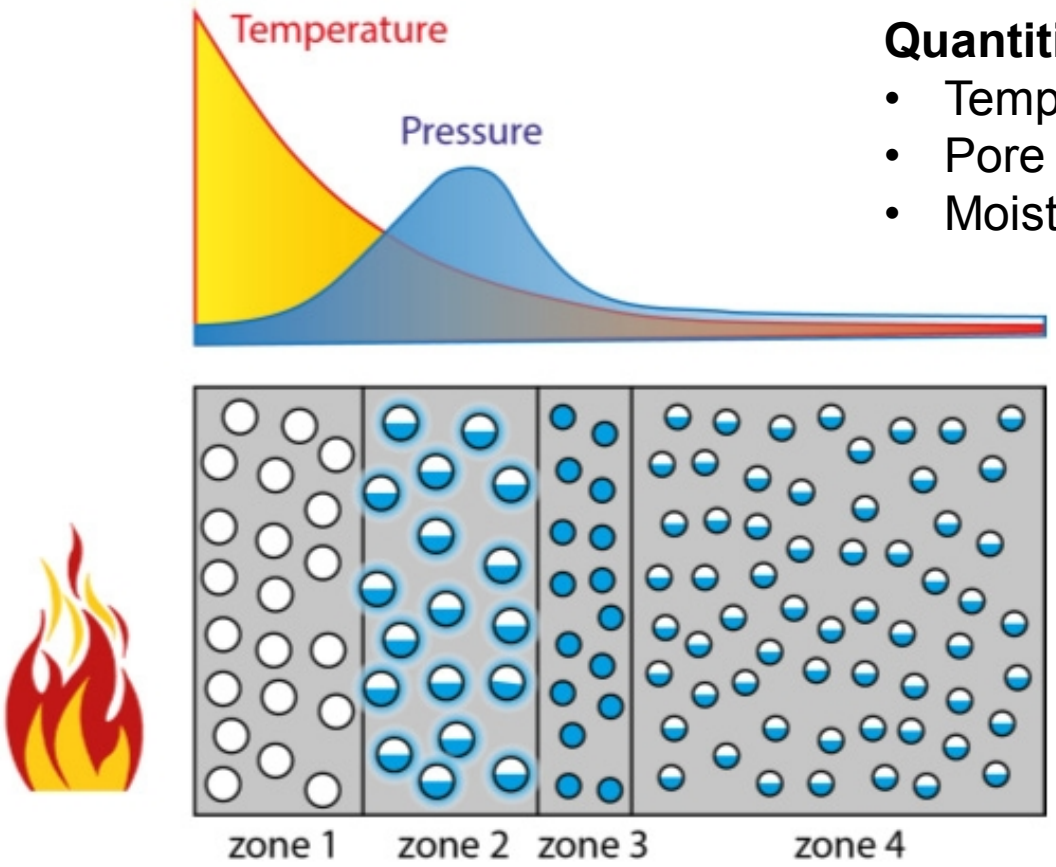


Quantities of relevance:

- Temperature
- Pore pressure
- Moisture transport

Combination of vapour pressure and thermal dilation

Experiments at NEUTRA, PSI

Real-time measurements of temperature, pressure and moisture profiles in High-Performance Concrete exposed to high temperatures

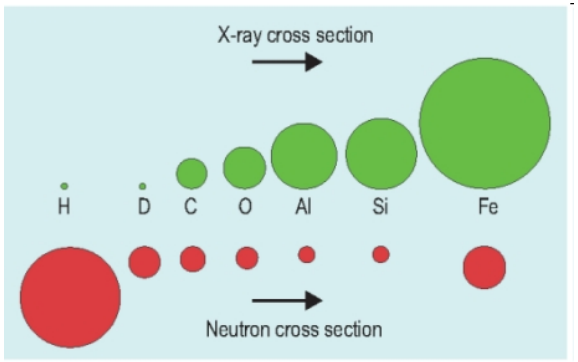
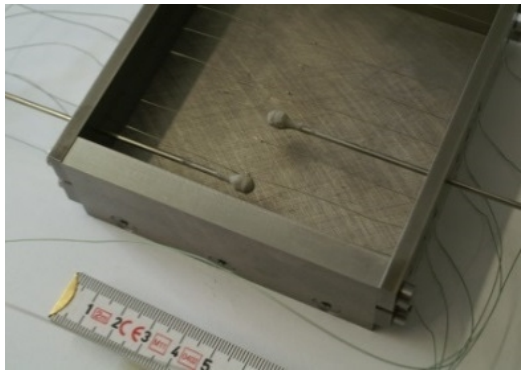


Fig. 2. Neutron and x-ray scattering cross-sections compared. Note that neutrons penetrate through Al much better than x rays do, yet are strongly scattered by hydrogen.

Source: NIST 2003

1)



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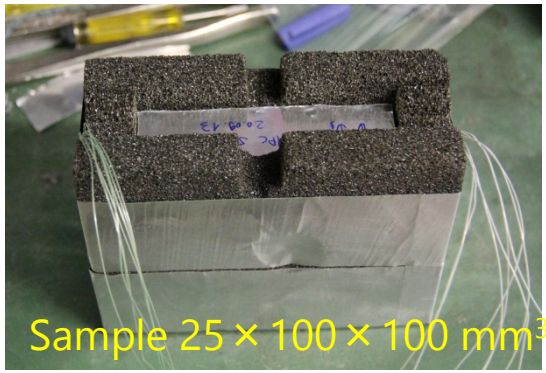

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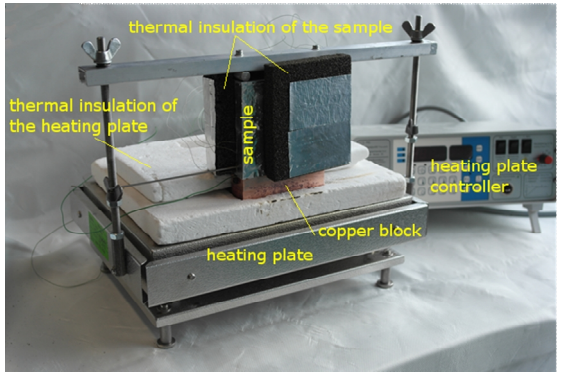

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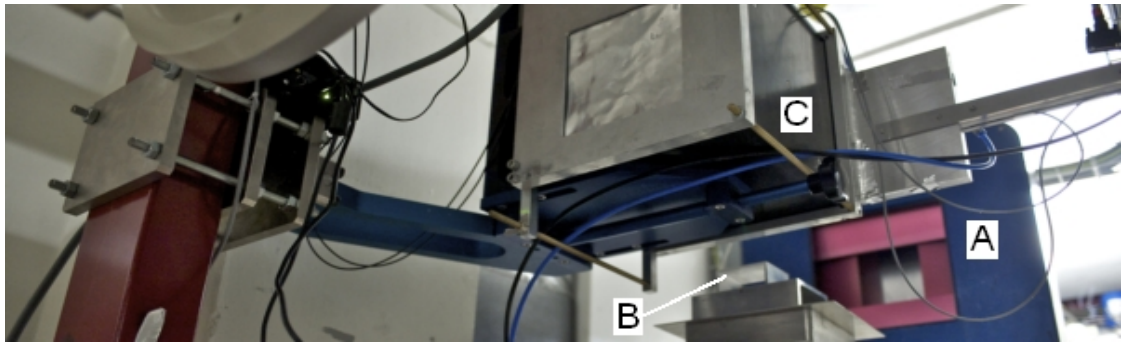
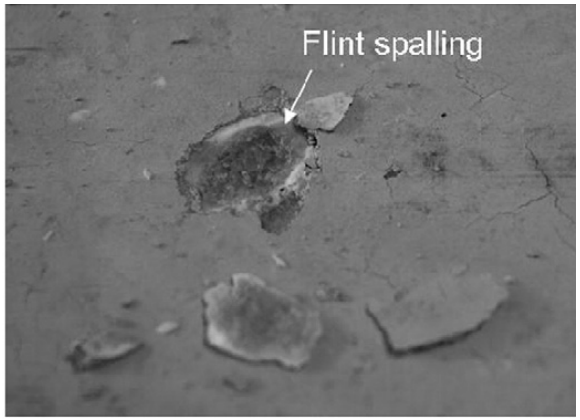


The NEUTRA beamline at PSI, combined neutron and X-ray radiography, a – neutron beam collimator; b –sample stage; c –detector.

Indication of problem



Mindeguia, 2010

Tunnel element from the Great Bealt tunnel fire tested at SP Technical Research Institute of Sweden.

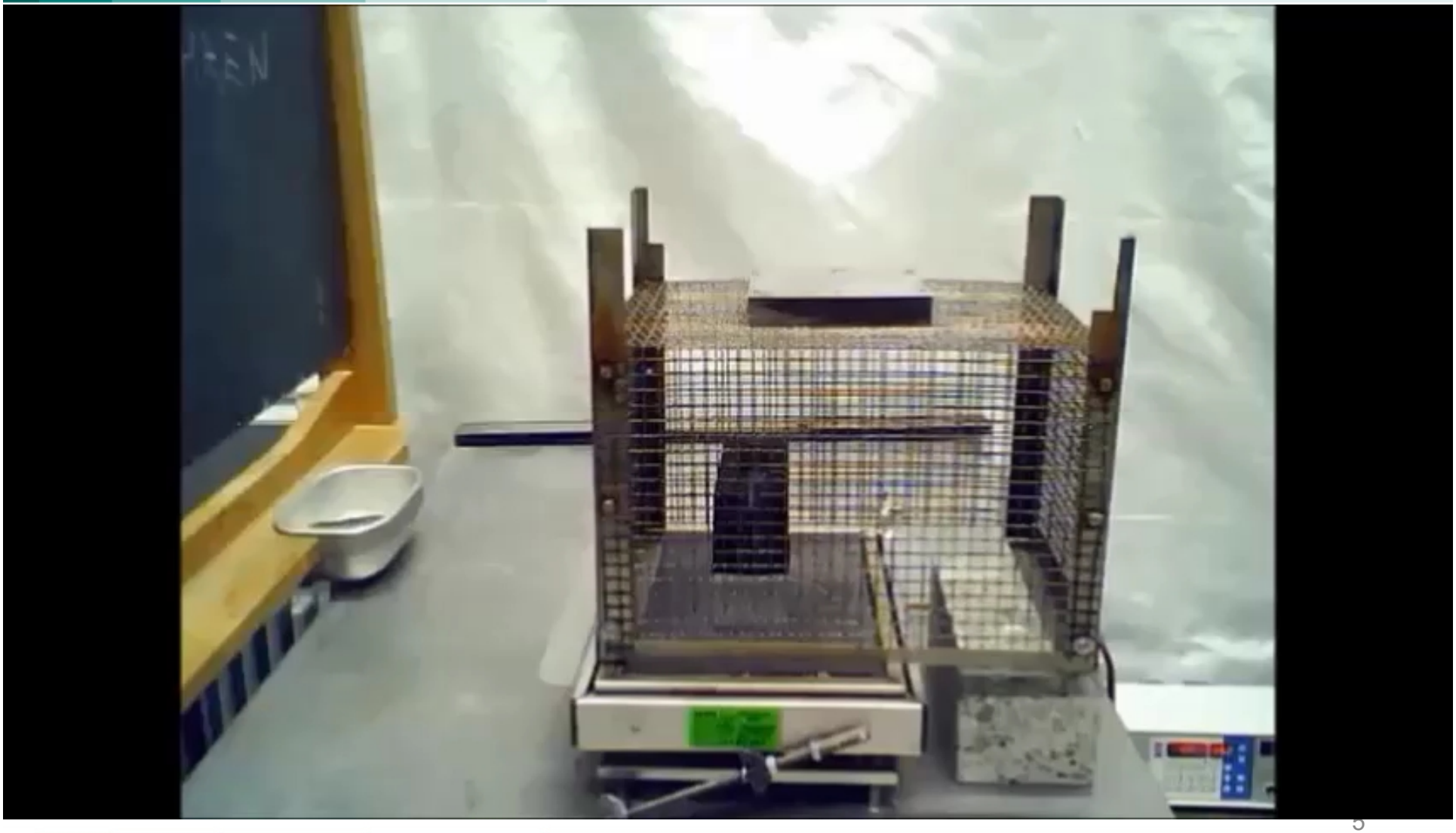
Channel Tunnel

Mont Blanc tunnel

Channel Tunnel

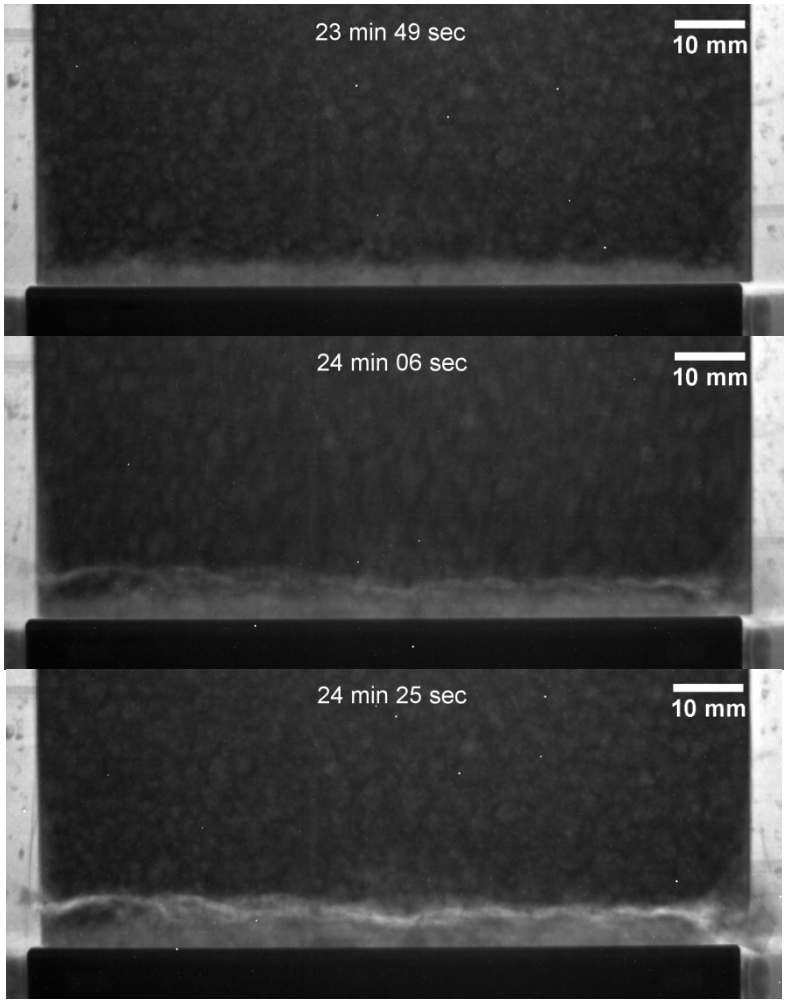
After testing in the laboratory, sometimes, you have to indicate the area of spalling, in real life it can be much more obvious

What to expect



Much more safer explosion inside open Neutron beam

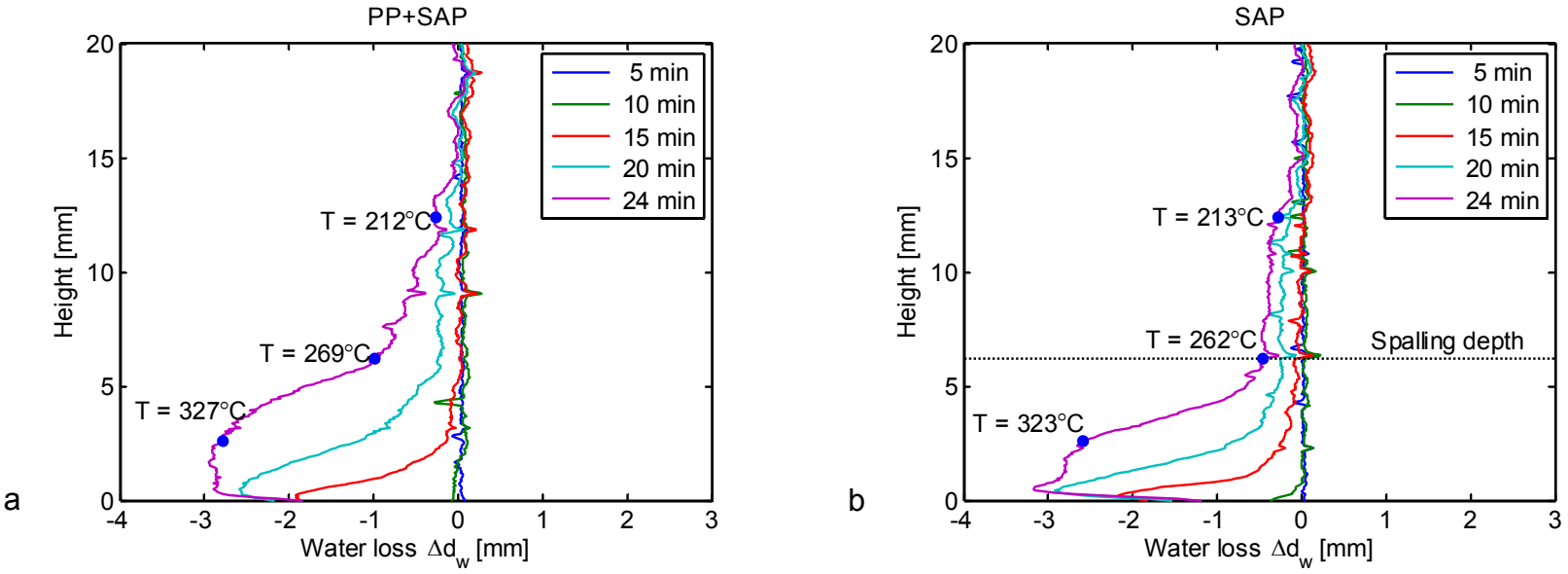
Spalling by Neutron radiography



Water loss profiles

Non-spalling sample

Spalling sample



Water loss profiles (expressed as equivalent thickness) of the lower 20 mm of the mortar slab: a) PP+SAP sample (no spalling); b) SAP sample (spalling occurred after 24 min at 6 mm height). Estimated temperatures at 24 minutes are indicated for characteristic points of the profile.

Neutron radiography combined with temperature and pressure measurements proves to be a useful method in following the processes that lead to spalling during fire

Thank you for attention! Questions?