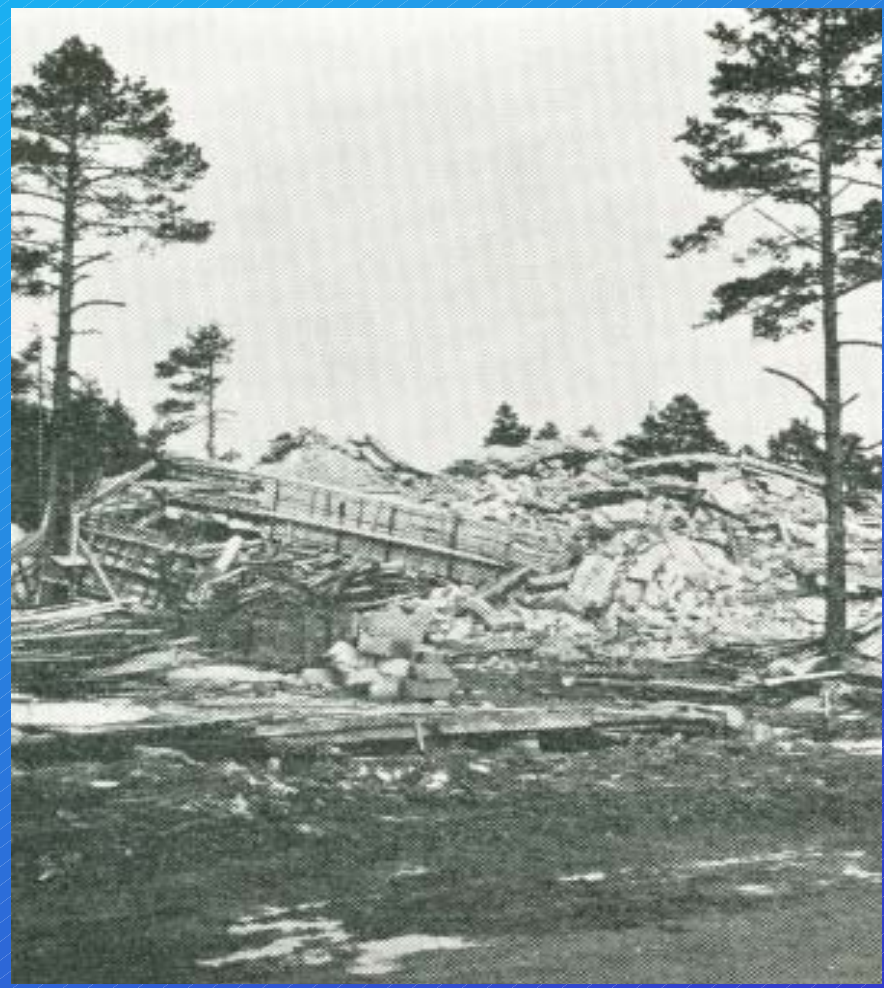
Lahti Finland 1963

April 11

April 12



Curing of Concrete

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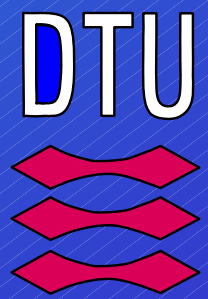
Building Materials Group
Technical University of Denmark



Curing technology
- planning and execution

Standard Input

- Heat development
- Strength development
- Mix composition
- Geometry
- Climate conditions
- …
- ...
- ...

Calculative assumptions

- Powers' model
- Time-temperature function
- Compled heat-moisture transfer
- …
- …
- ...

Design criteria / output

- Max saturation
- Max evaporation
- Max temperature gradient
- Min strength
- …
- …
- …

Curing - Definition

Maintenance of moisture and temperature

for a period of time after placing

to assure desired concrete properties to develop

Desired concrete properties

- Strength
- Durability
- Aestetics

Necessary curing time

3 hrs – 3 weeks ?

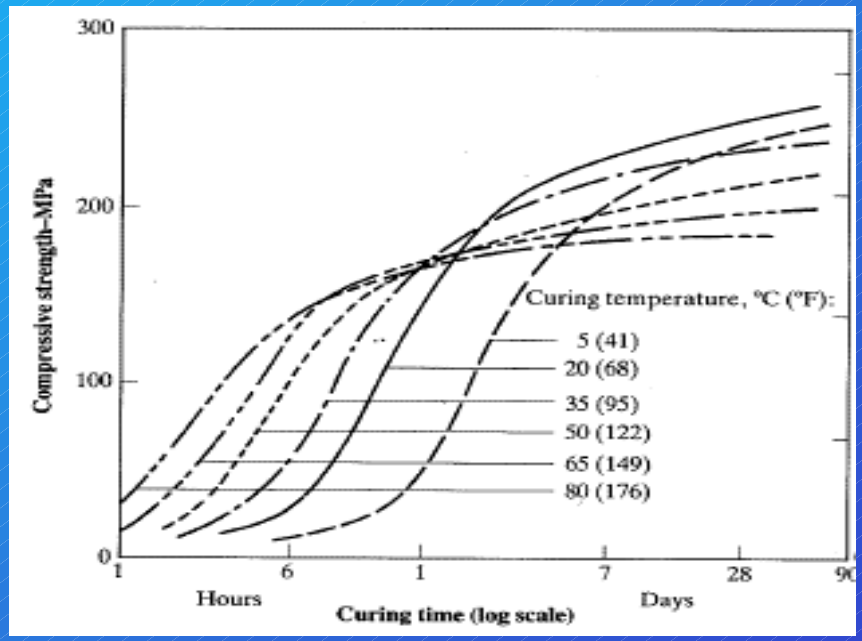
- Typically 1-10 days

Important:

- Start ASAP
- Continuity!

Temperature

Not too low! - Not too high!

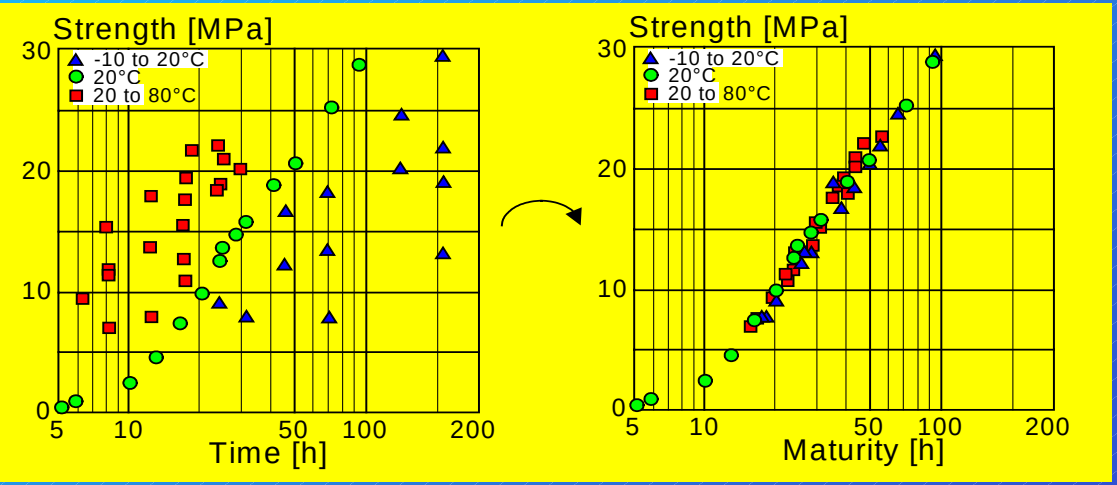


Optimum temperature: 10-20°C?

Temperature
- Maturity concept

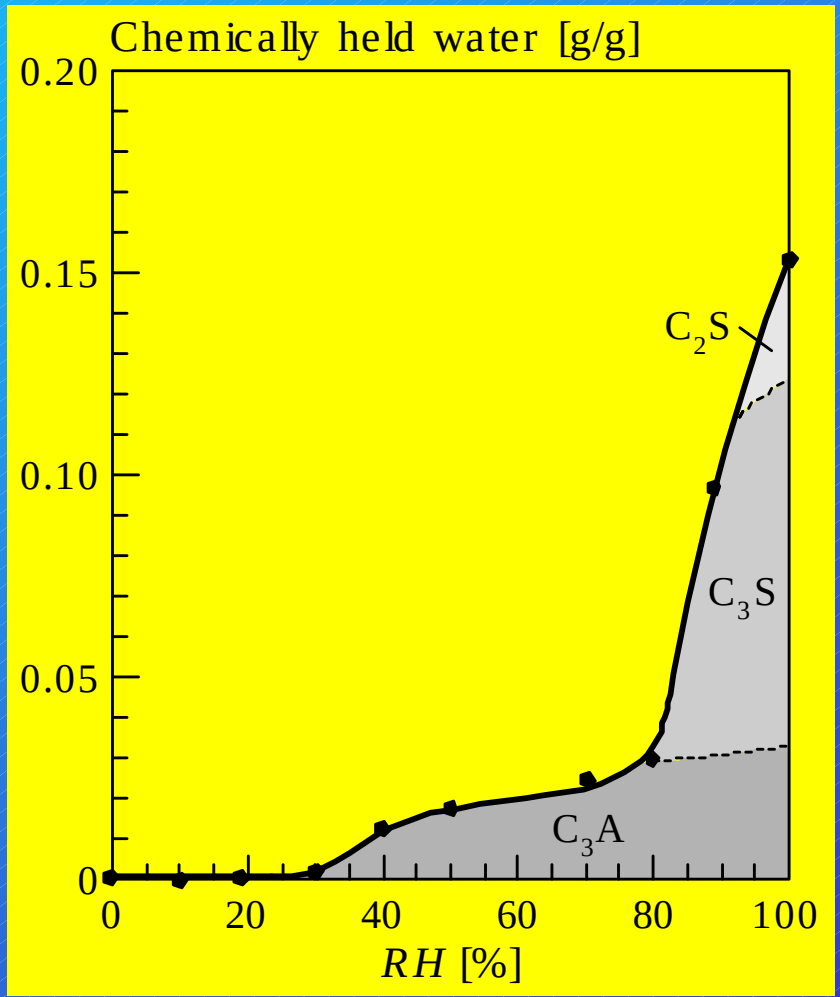
- Mathematical time-temperature transformation

$$H(\theta) = \begin{cases} k \cdot \theta & \text{Nurse} \\ k \cdot (\theta + 10) & \text{Saul} \\ k \cdot 2^{(\theta/10)} & \text{Rastrup} \\ k \cdot \exp\left(- \dfrac{E_a}{R(\theta + 273)} \right) & \text{Freieslebe n Hansen} \end{cases}$$



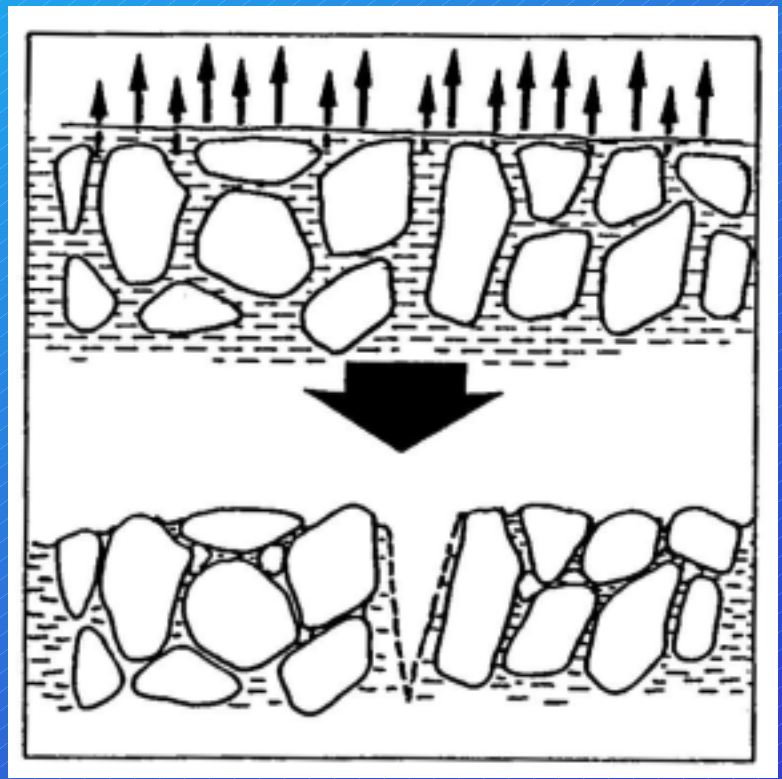
Moisture
- influence on hydration rate

Keep it moist!



Moisture
- plastic shrinkage cracking

- High evaporation during plastic phase
  - high concrete temperature
  - low air humidity
  - high wind speed



Moisture - curing methods

(RILEM ICC, 2005)

Moisture
- external methods for maintenance

- Ponding/immersion
- Fogging/sprinkling
- Wet coverings
- Impervious covering
- Sprayable membranes
- ...

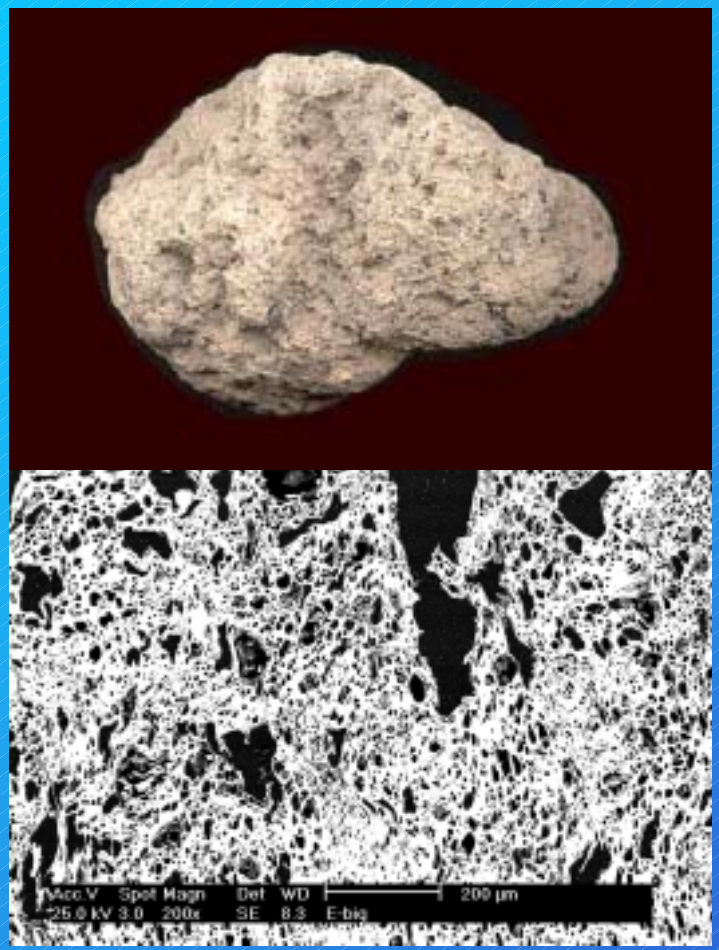
Moisture
- internal water curing

Why not external curing?

- Extra labor
- Quality assurance
- Inaccessible surfaces
- Low permeability

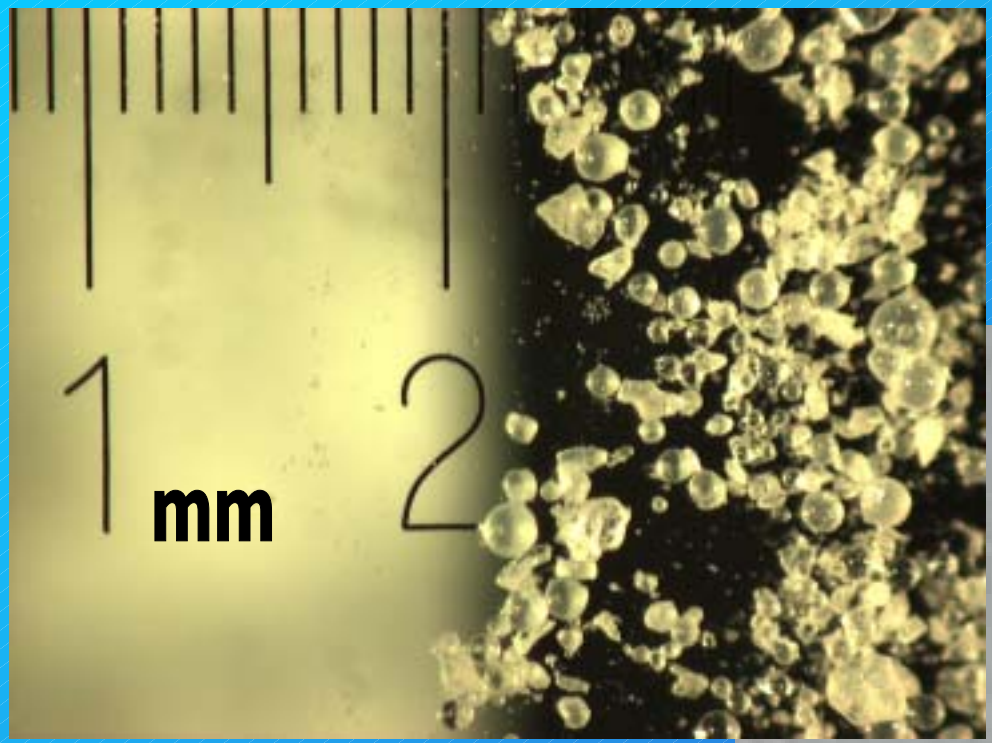
Lightweight aggregate

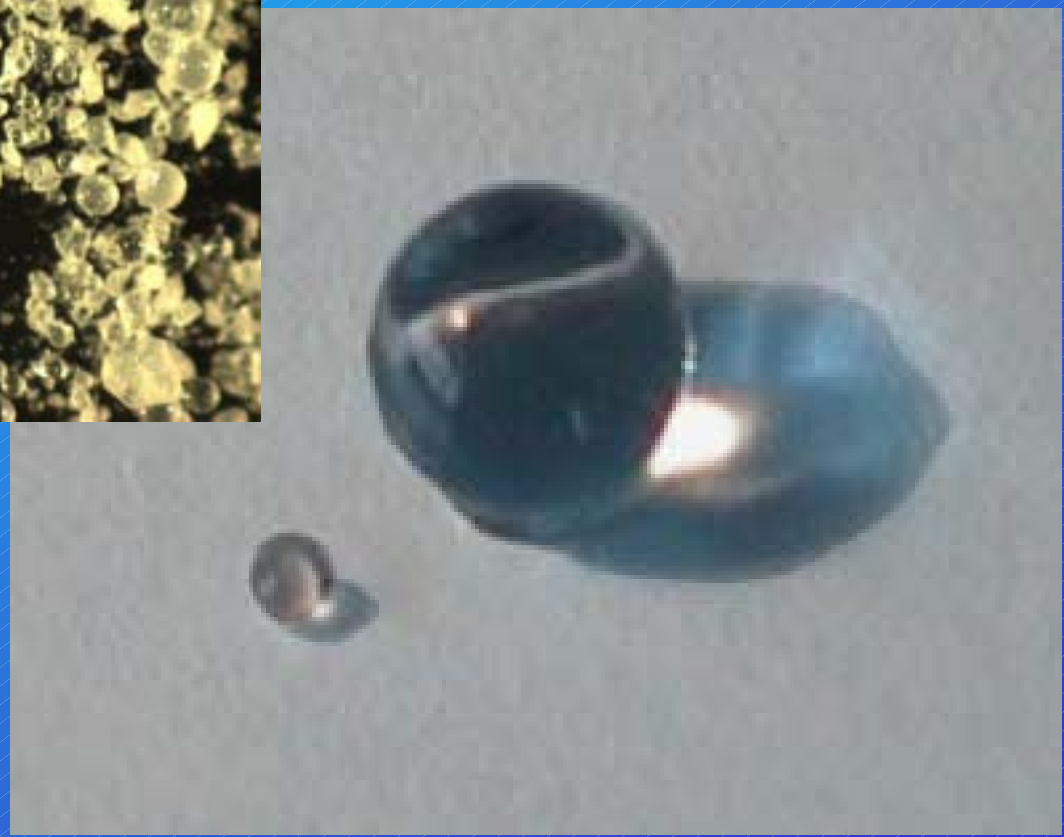
Crushed pumice



Expanded shale

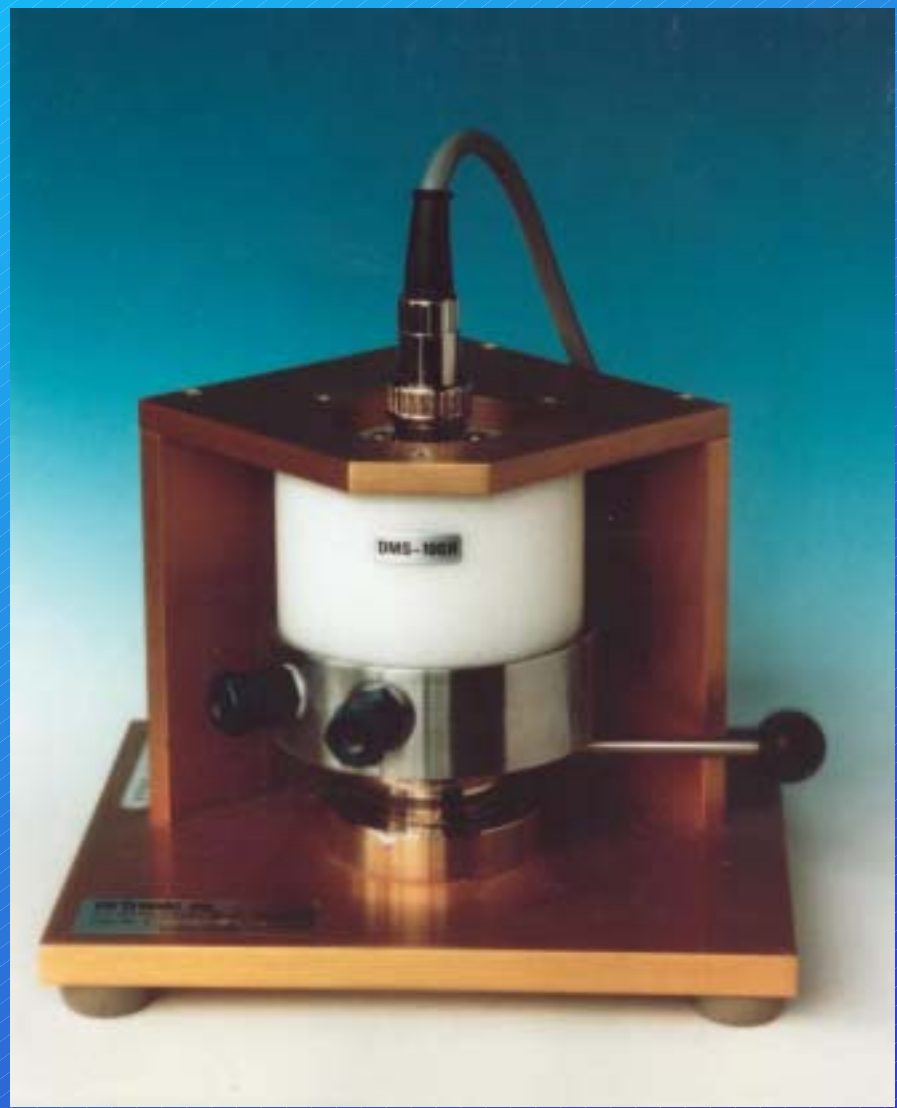
Superabsorbent polymers (SAP)





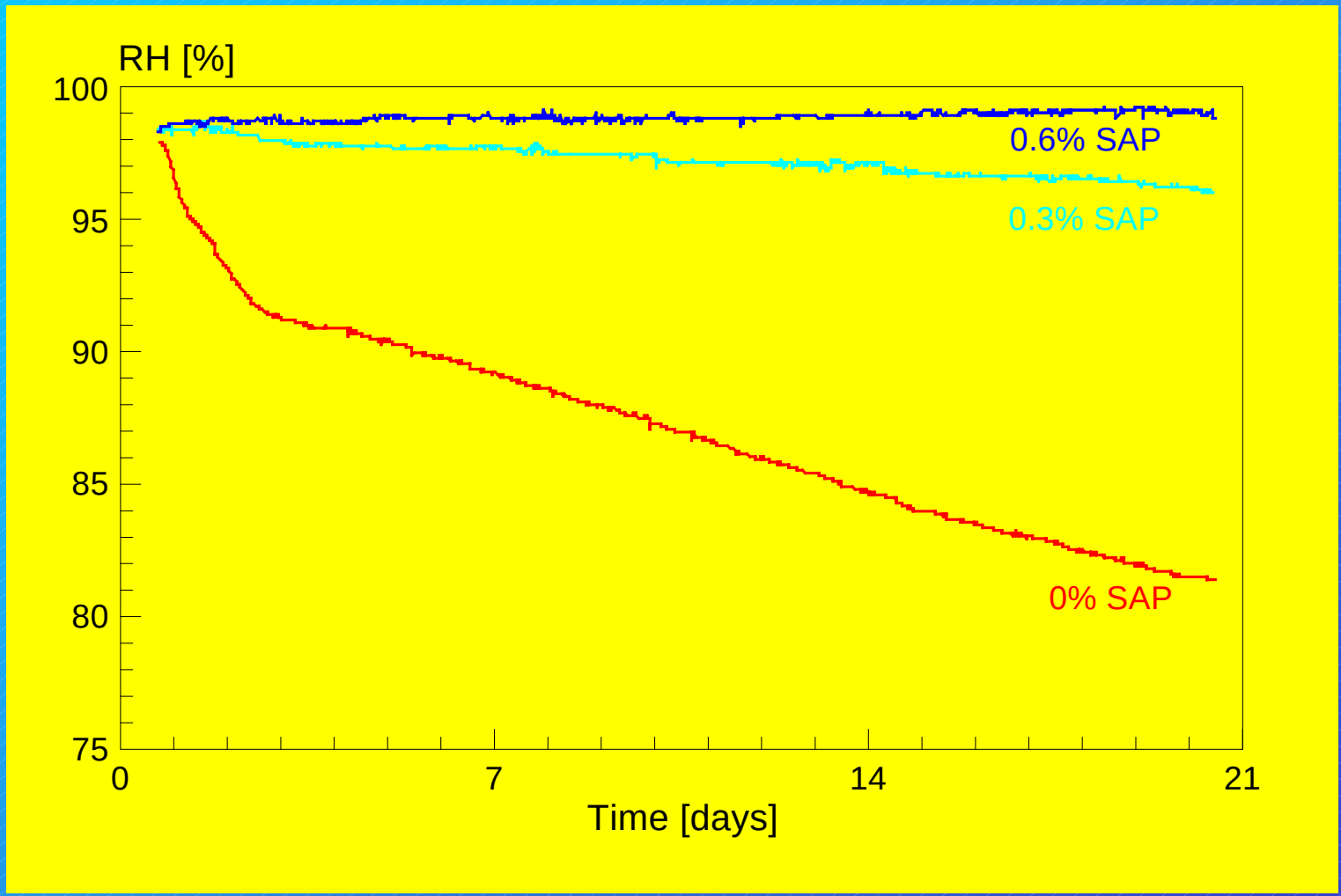
Autogenous relative humidity

Rotronic Hygroscop DT



(Jensen & Hansen 1988)

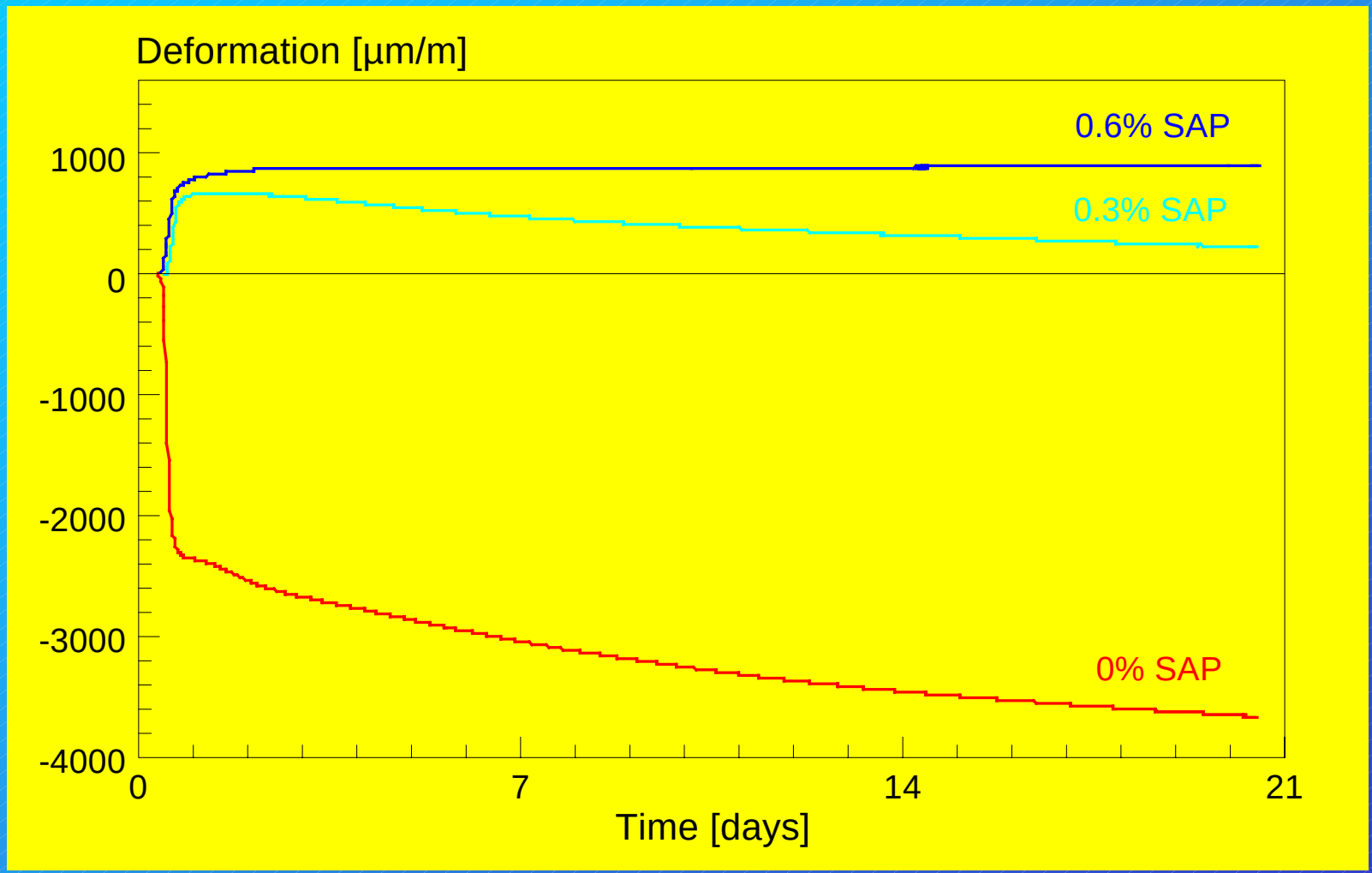
Autogenous relative humidity

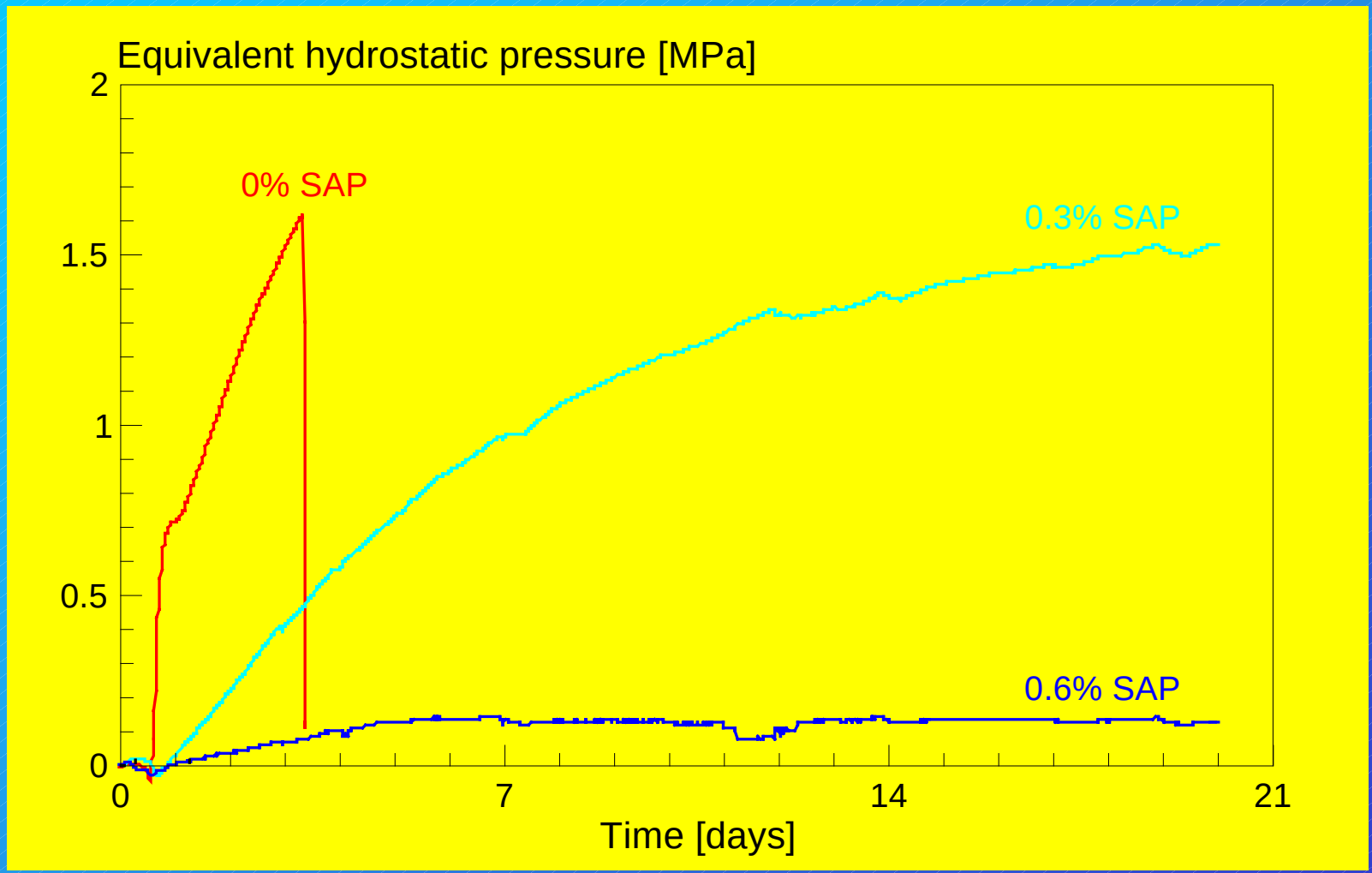


Autogenous strain

(Jensen & Hansen 1988)

Autogenous strain



Stress build-up

Stress build-up