Influence of curing temperature on development of compressive strength and resistance to chloride ingress of concrete with different binder systems

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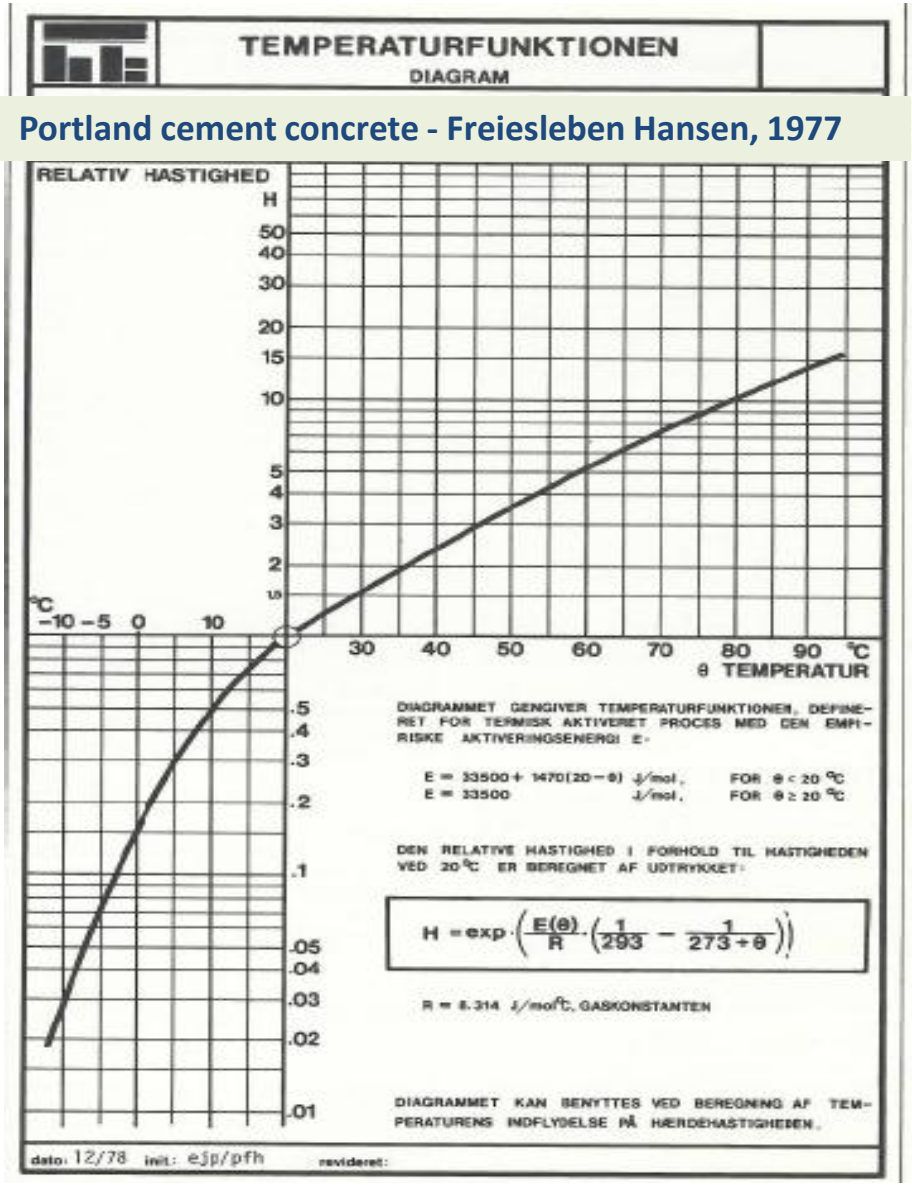
Background

Scope 1

- In Denmark, the maturity concept is used for estimating the strength development of a concrete as a function of temperature – based on data measured at 20 degrees

Input to:

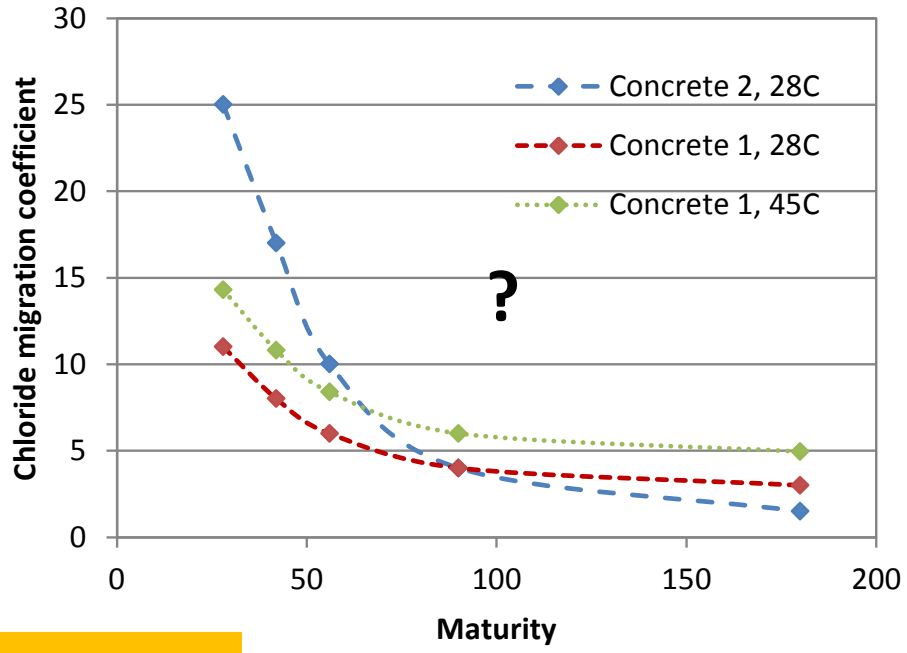
- Optimization of curing
- Striping of formwork
- Evaporation protection
- Selection of binder combination
- Early age crack control



Background

Scope 2

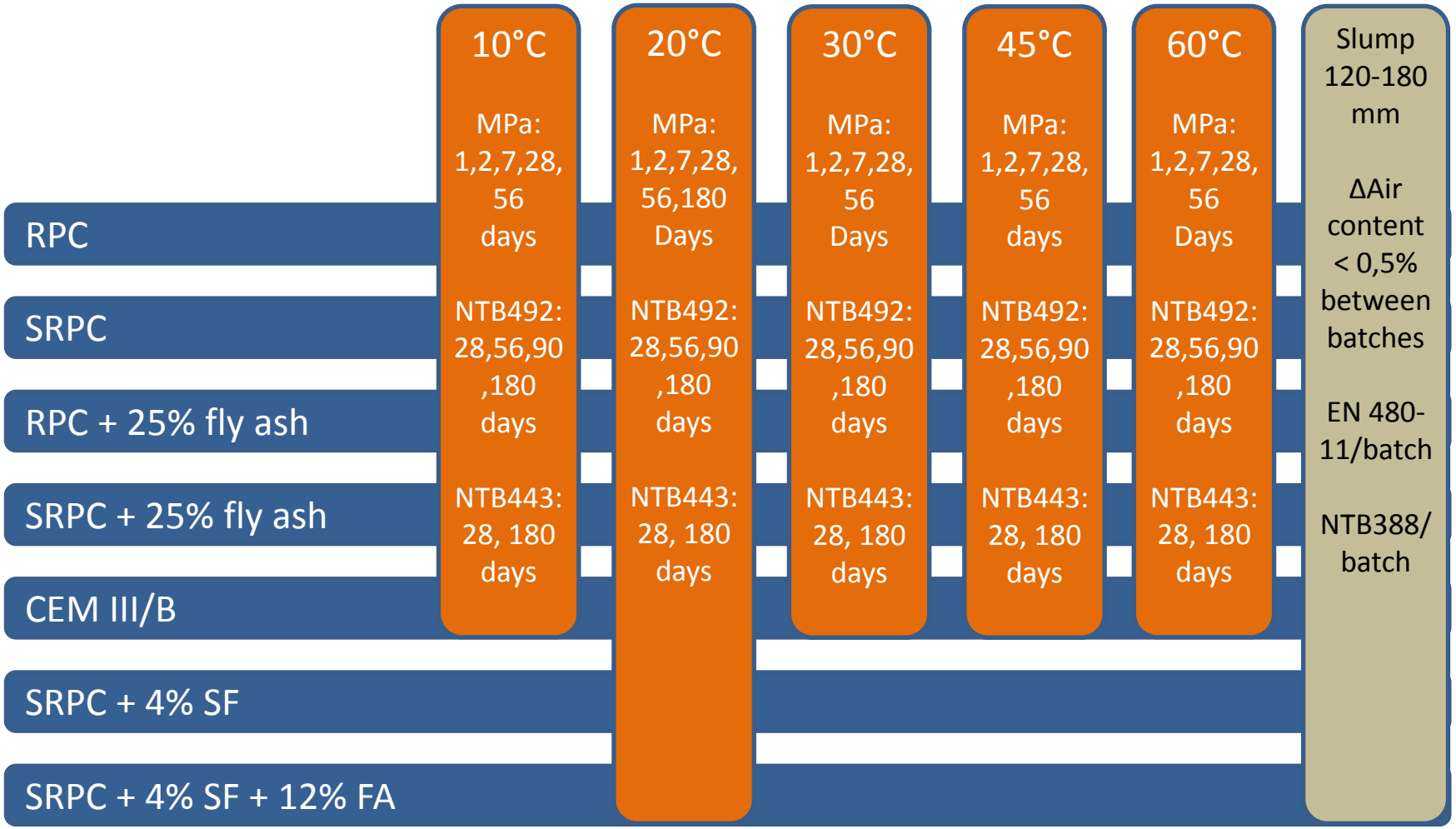
Is it possible to use a similar relation to describe the development of resistance to chloride ingress??



Input to:

- selection of binder combination
- optimization of curing
- choice of maturity at first exposure

Experimental program



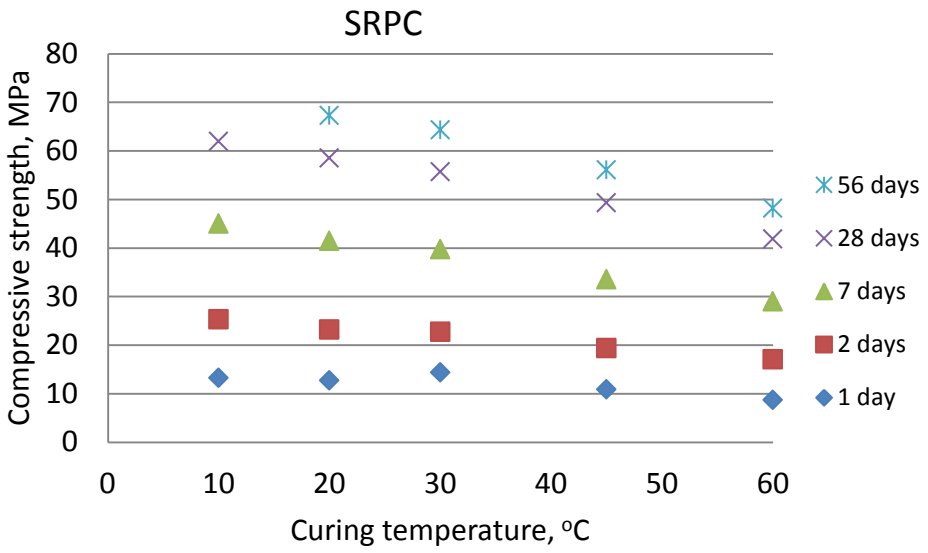
Each concrete type: eq. w/c-ratio at 0.40, dmax = 22 mm

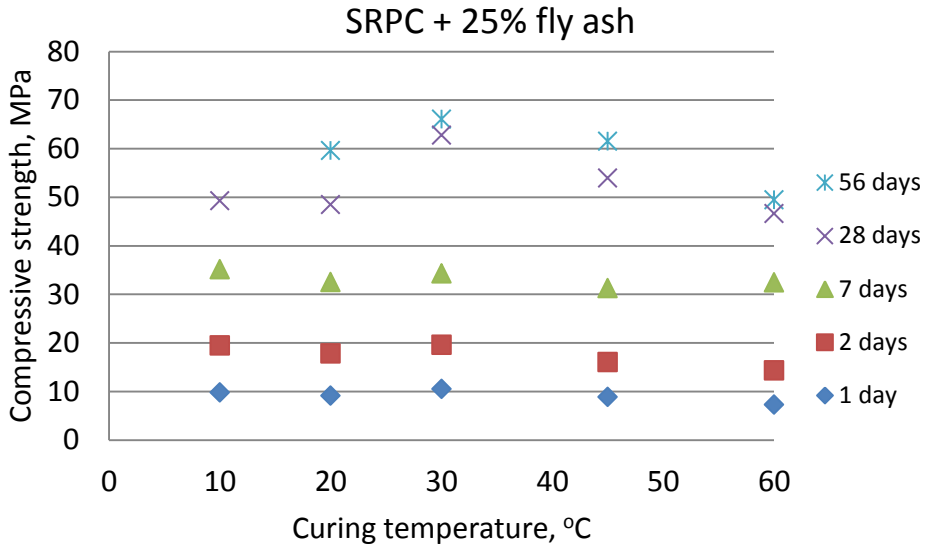
78 Ø150 cylinders
30 Ø100 cylinders
} 500 liter

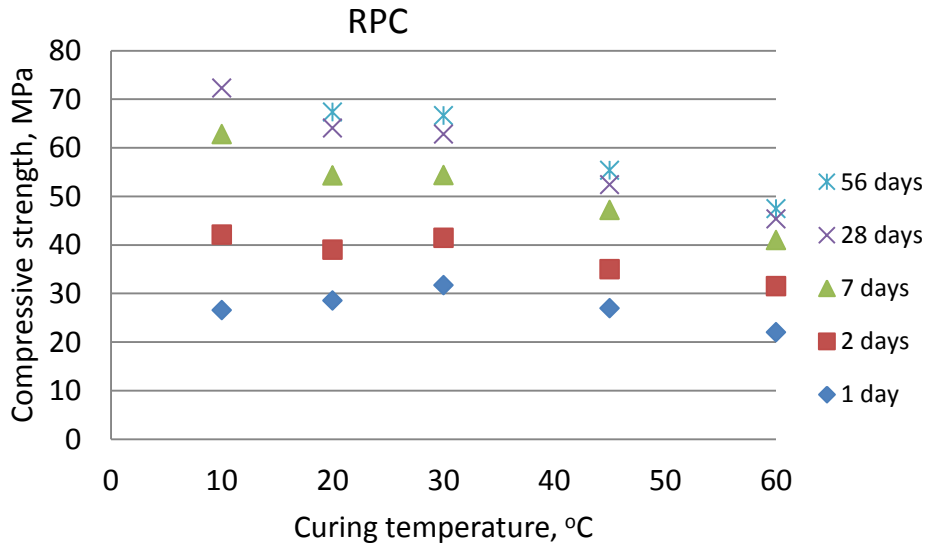
CONCRETE
EXPERTCENTRE

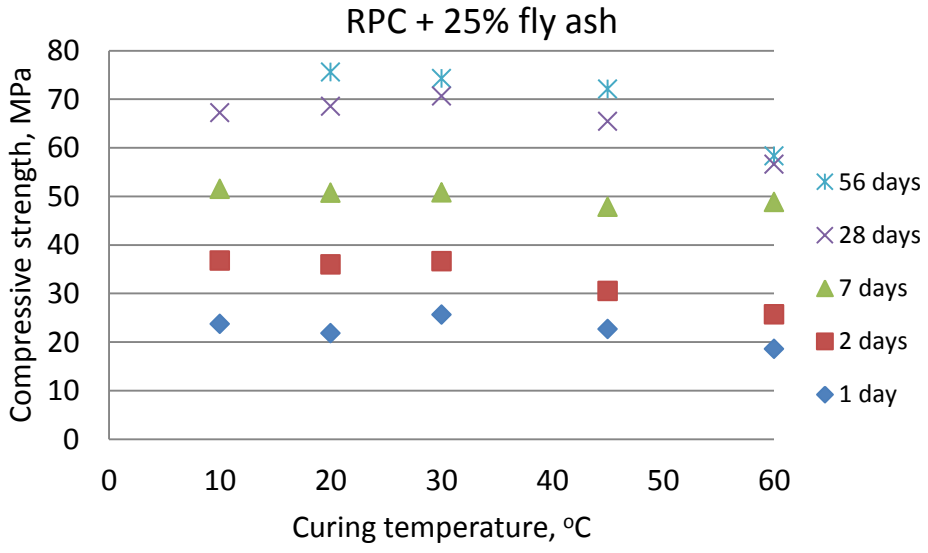
CONCRETE EXPERTCENTRE

Strength development (in Maturity-days)

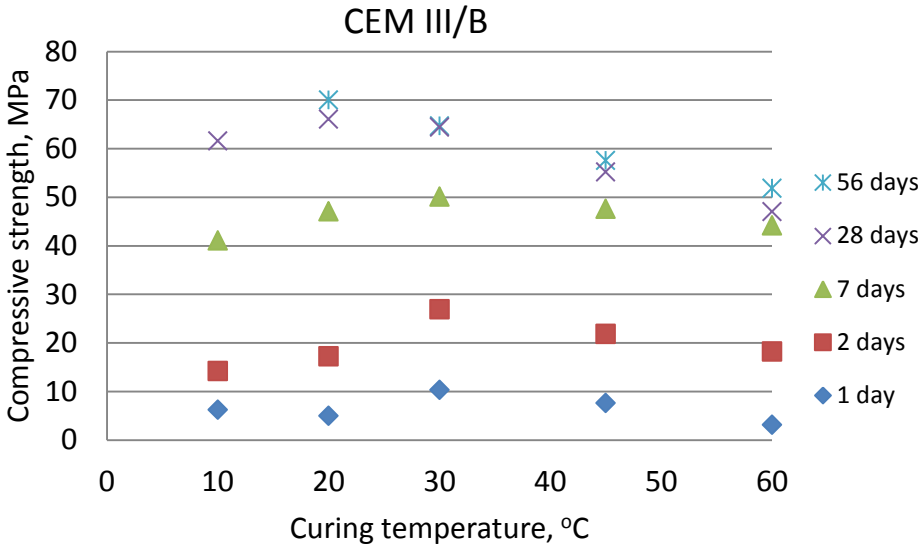




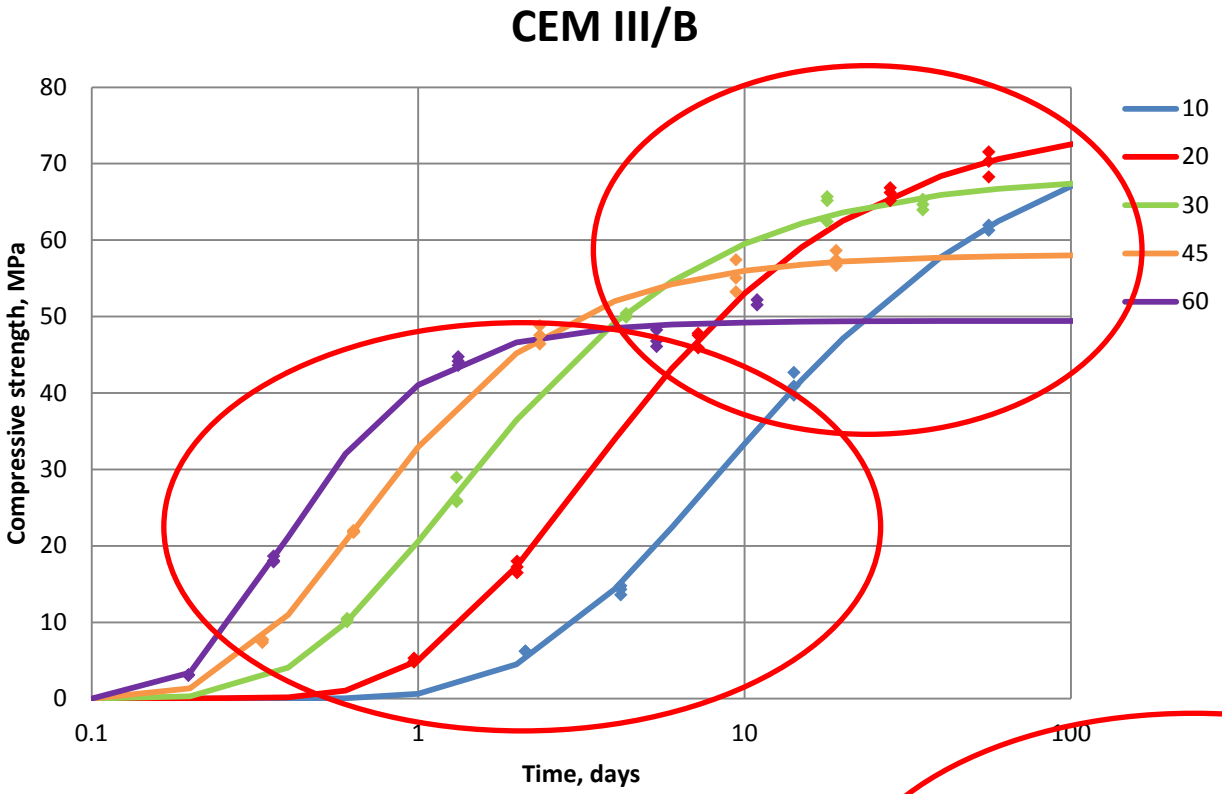




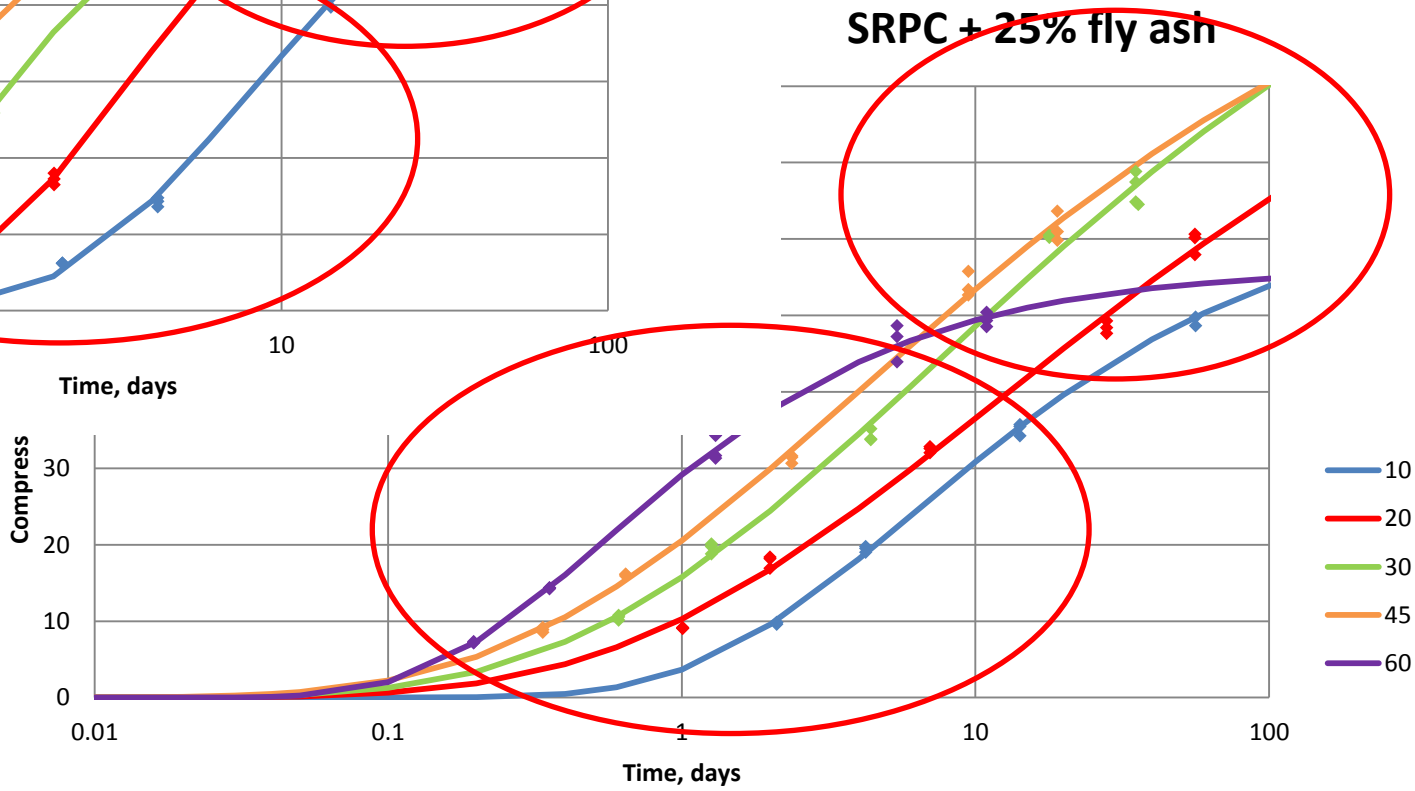
Strength development (in Maturity-days)



Strength development

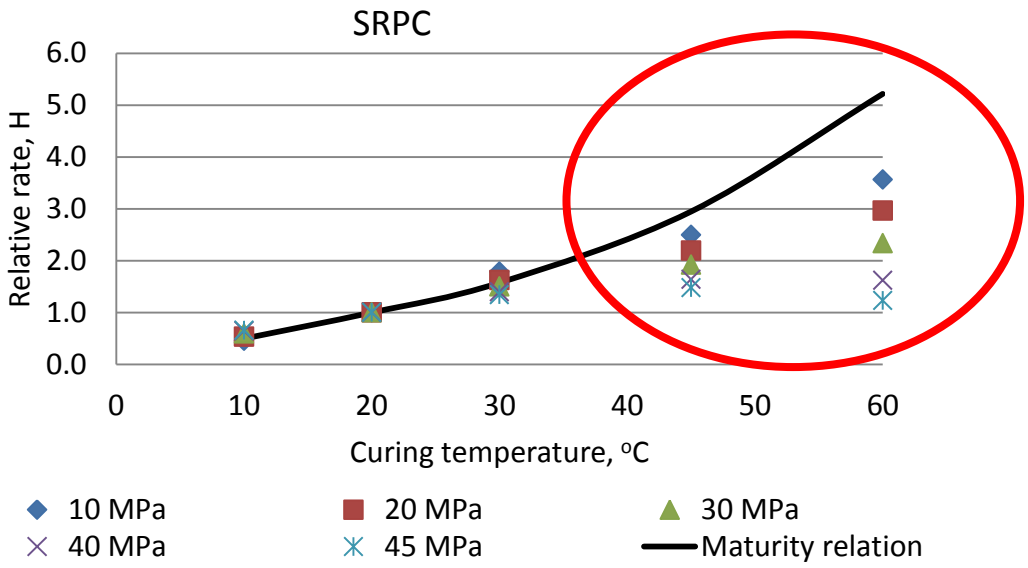


Ultimate strength significantly affected by curing temperature?



Rate is examined up to 45 MPa for practical purposes

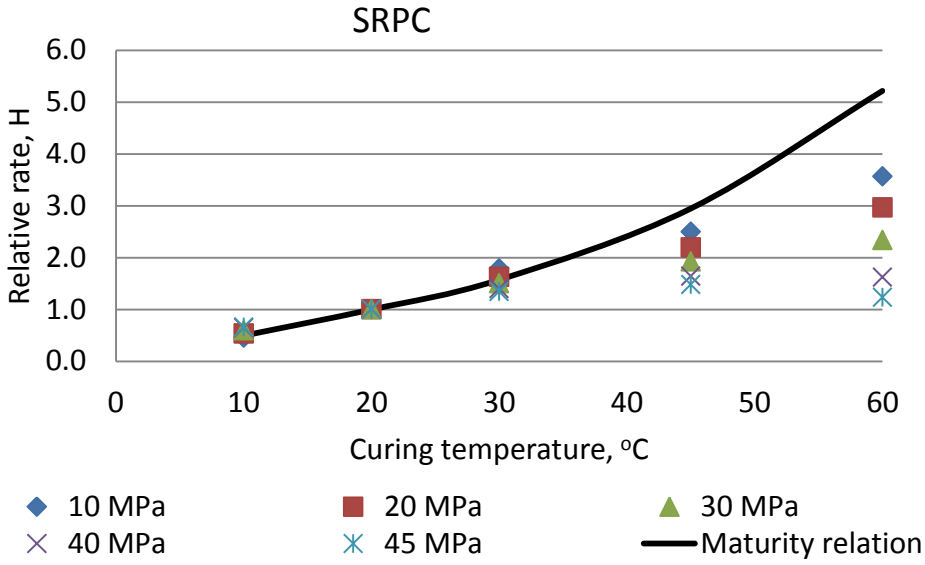
Relative rate of strength development

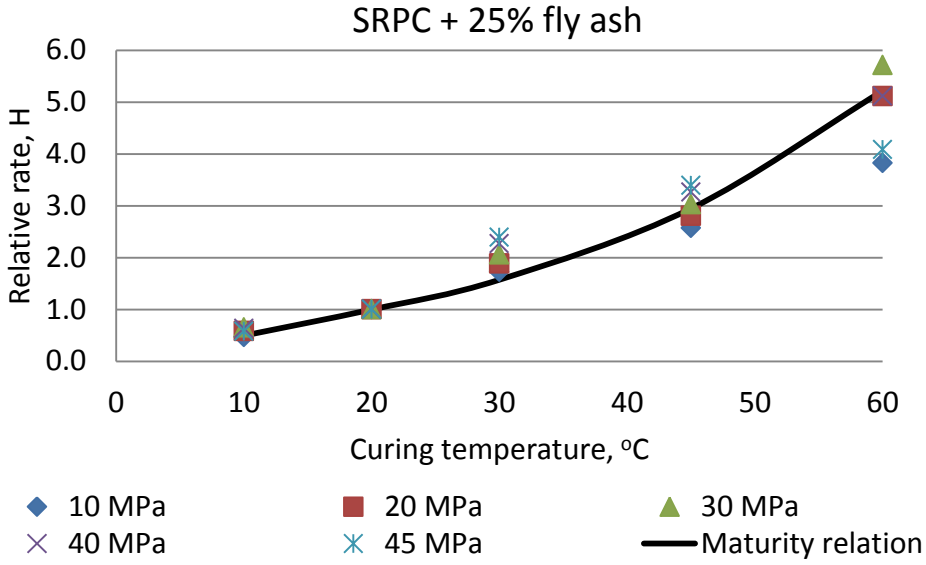


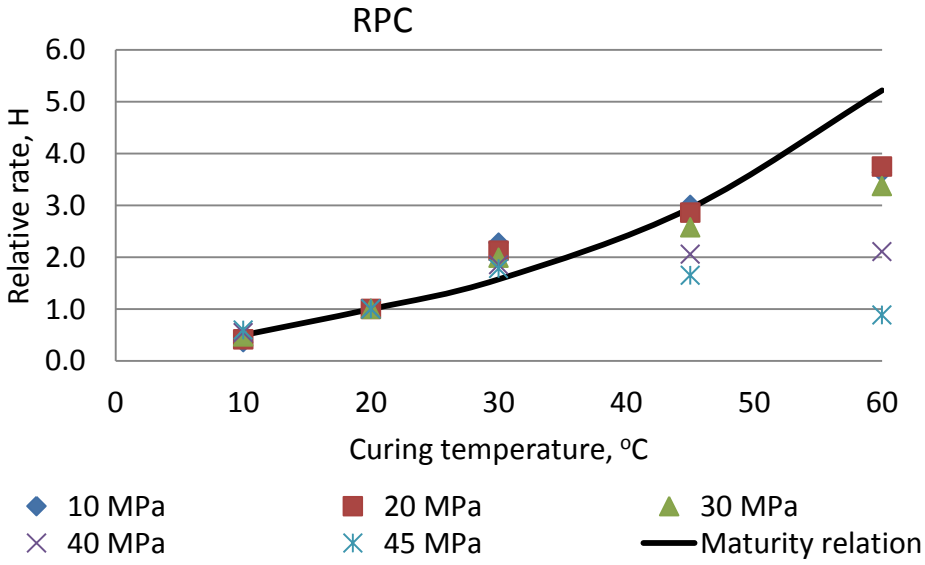
At high temperatures, the rate of strength development is devendent on the degree of hydration!

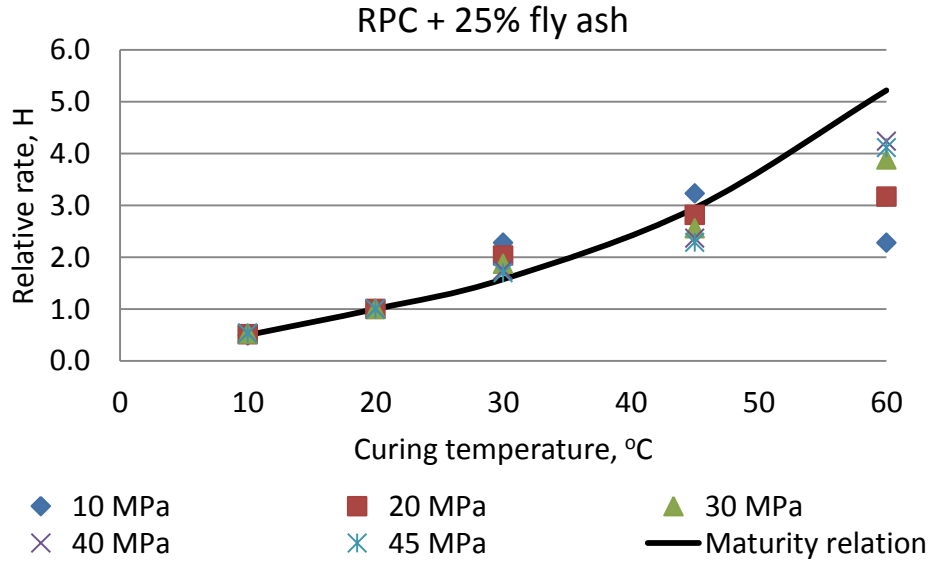
The energy of activation may be a function of temperature!

Relative rate of strength development

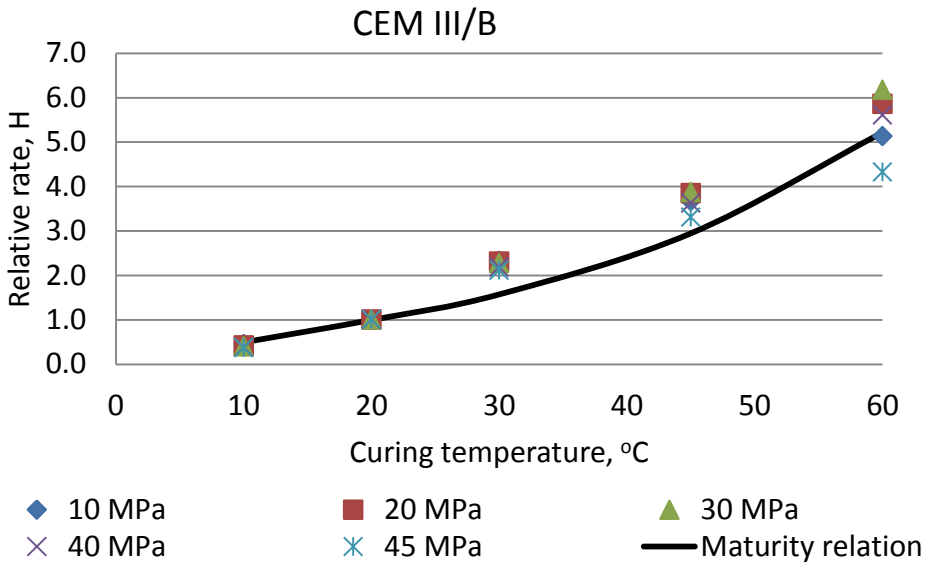




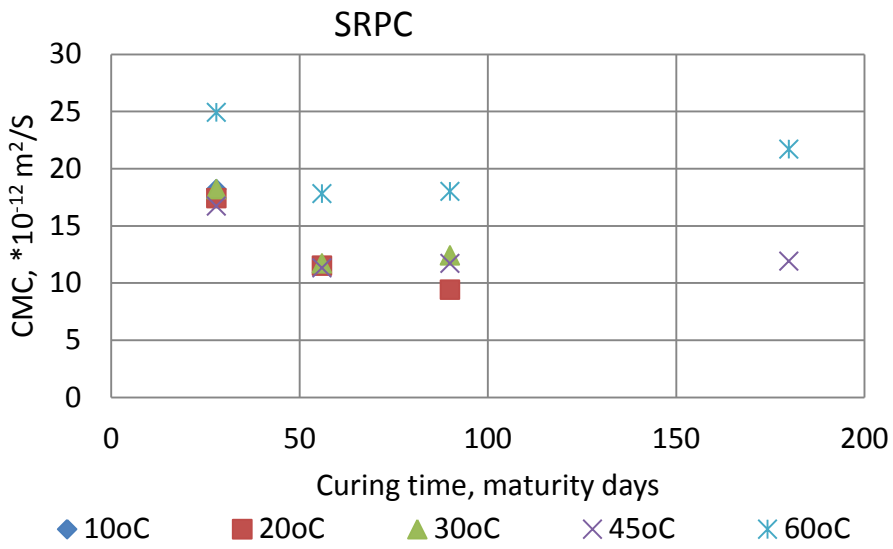


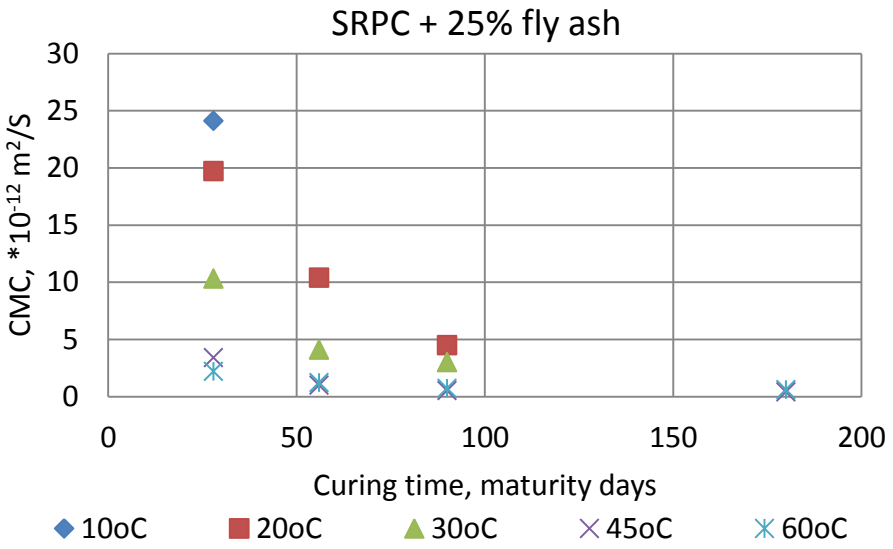


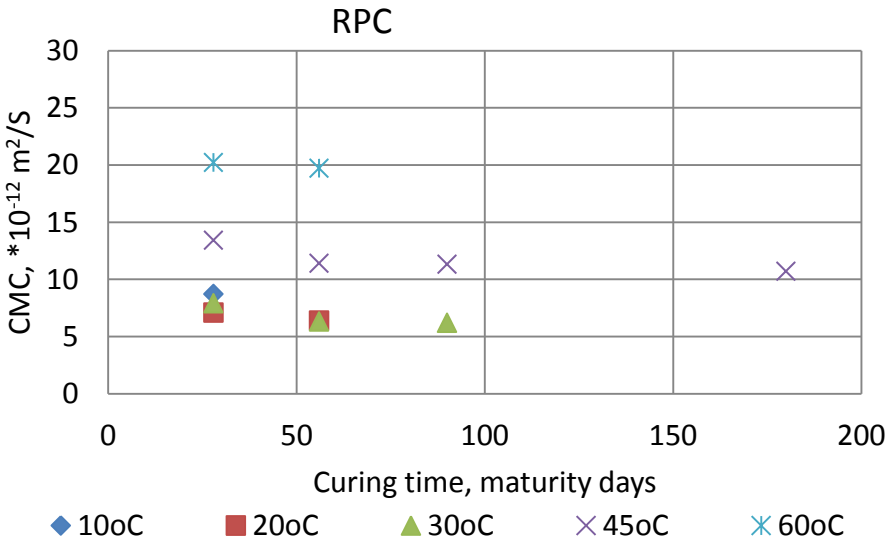
Relative rate of strength development

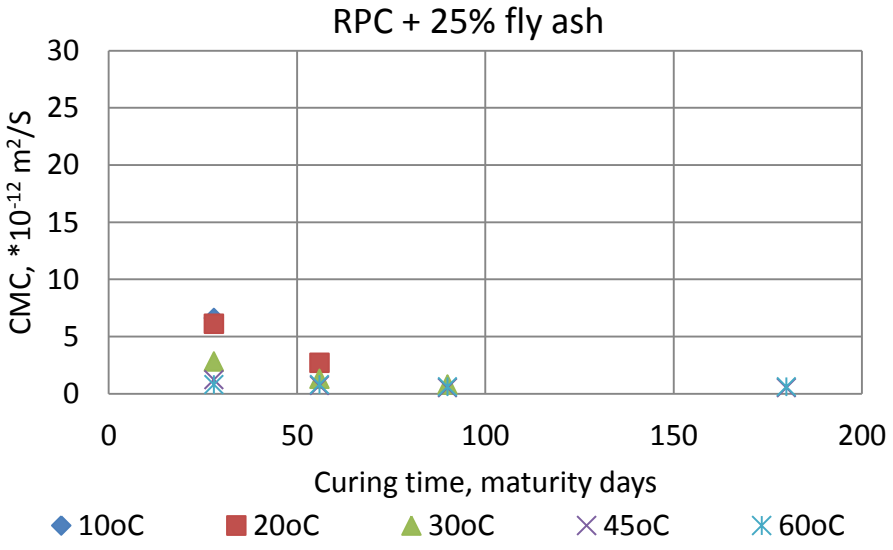


Resistance to chloride ingress (CTH vs. maturity days)









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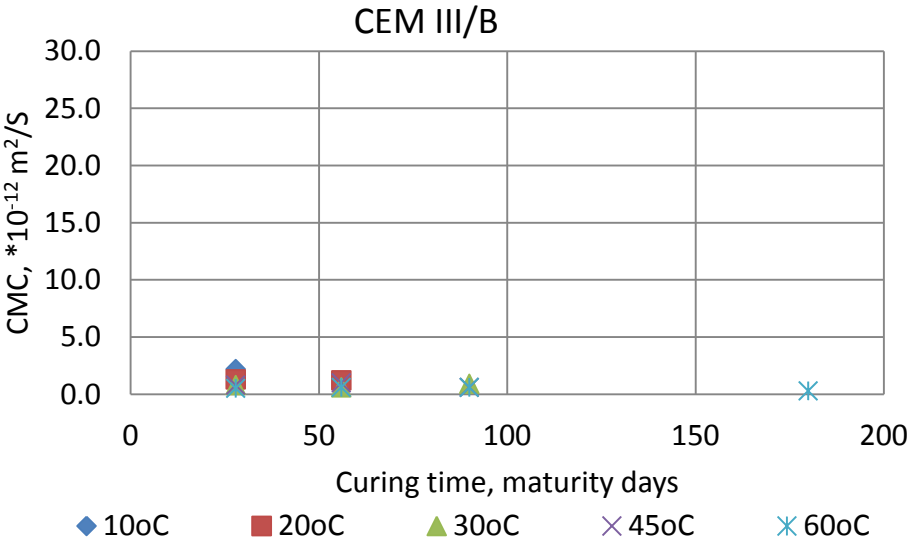
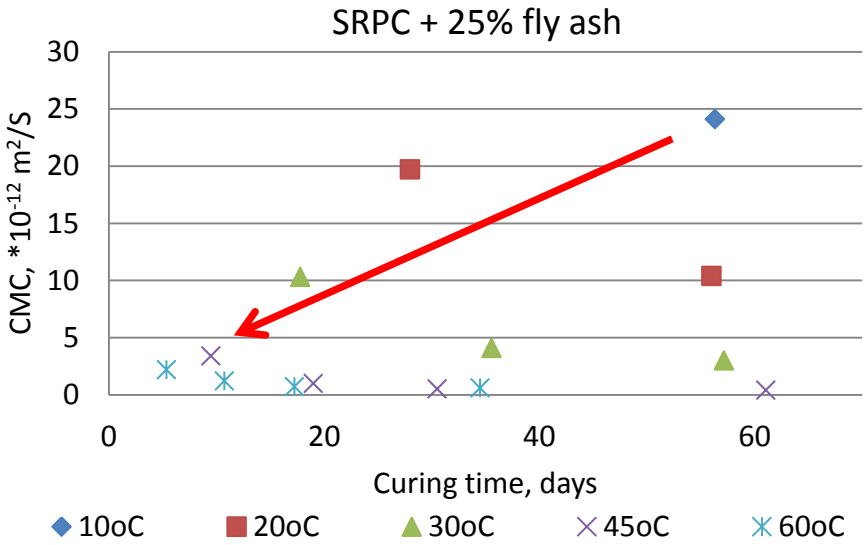
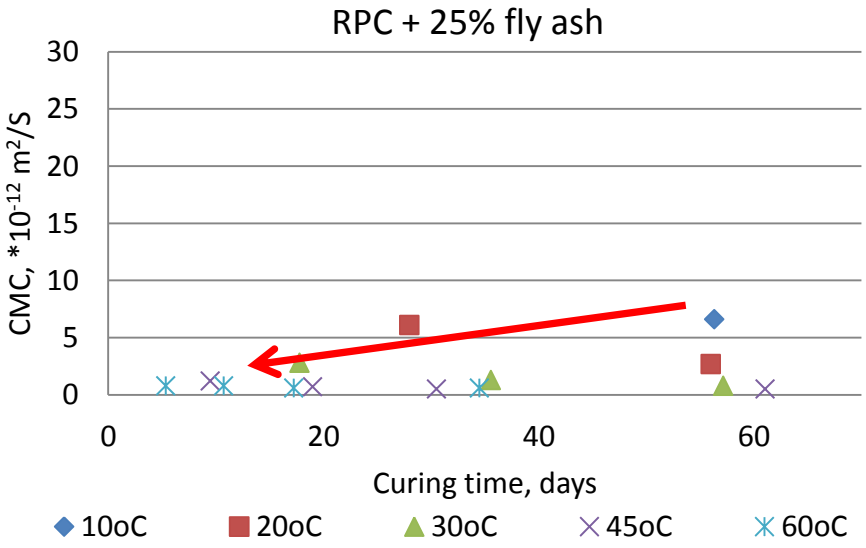


Resistance to chloride ingress

- Practical implications – curing strategy





Concluding remarks

- The maturity relation by Freiesleben provides an accurate description of the rate of strength development for curing temperatures up to ~30 ^{o}C
- The accuracy of this relation drops significantly for curing temperatures above 30^{o}C, where the rate becomes highly affected by the degree of hydration
- The ultimate strength of a concrete is remarkably affected at curing temperatures around 60 ^{o}C
- Performance of fly ash concretes is greatly improved by high-temperature initial curing
- Slagcement concretes show very good resistance to chloride ingress at short curing times and at all studied curing temperatures
- All studied concretes show remarkably different behaviour with respect to both strength development and resistance to chloride ingress, and therefore…
    - it is recommended to carry out perfomance testing of a concrete at different temperatures prior to execution, in order to plan an optimum curing strategy