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Experimental determination of chloride threshold values for reinforcement corrosion in concrete: Experiences form the lab

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Chloride threshold values

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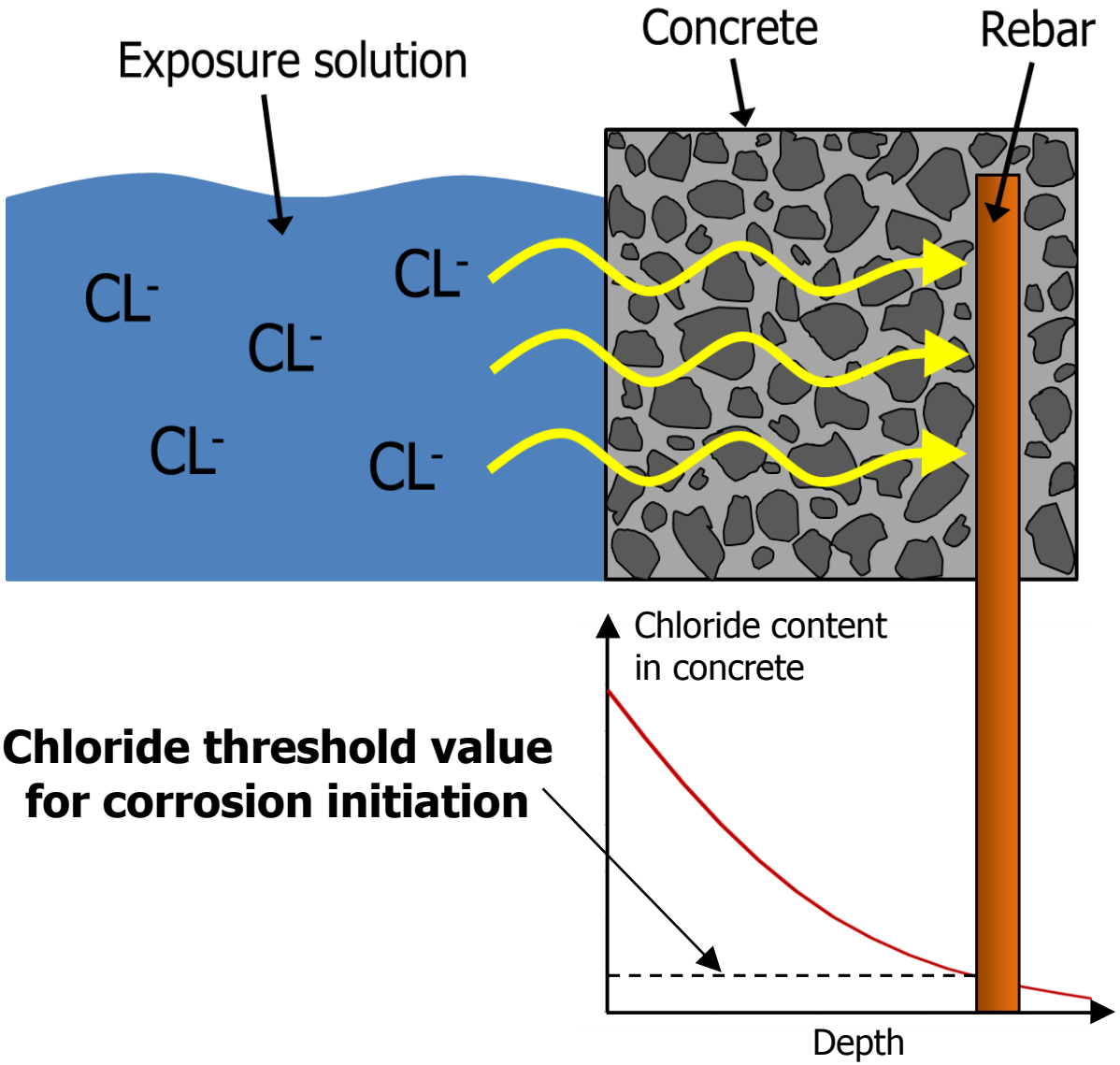

Determination of chloride threshold values in the lab

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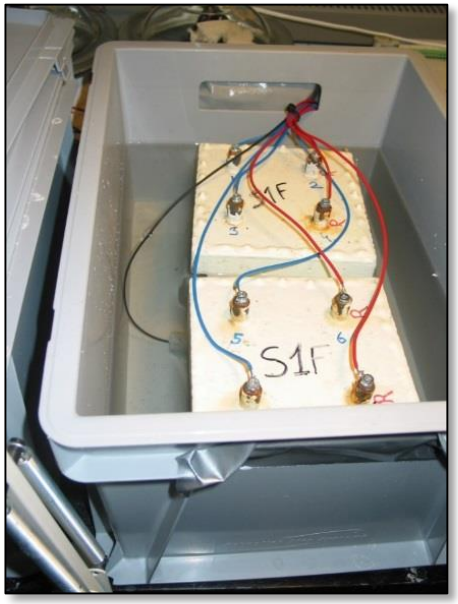
- Concrete specimens exposed in 6 wt% NaCl solution
- Principle: Chloride concentration is measured at the depth of the rebars when corrosion onset is observed → chloride threshold value
- Two experimental approaches used for detection of corrosion onset:
  - Open circuit setup
  - Potentiostatic setup (fixed potentials)



Concrete specimens

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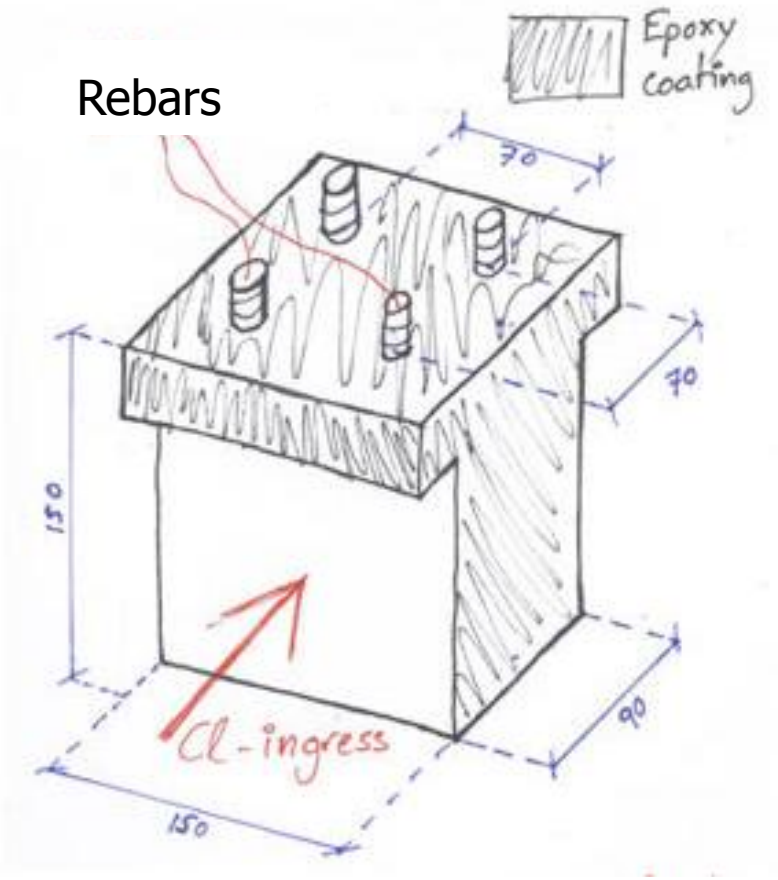

Schematic illustration of concrete specimen

- CEM I 52,5 N Portland cement + 25% fly ash
- w/b = 0.40
- Granitic aggregates (d_{max} = 8 mm)
- Cast-in rebars (as-received or chemically cleaned)
- Cover thickness: 5 or 15 mm

Overview of experimental setup

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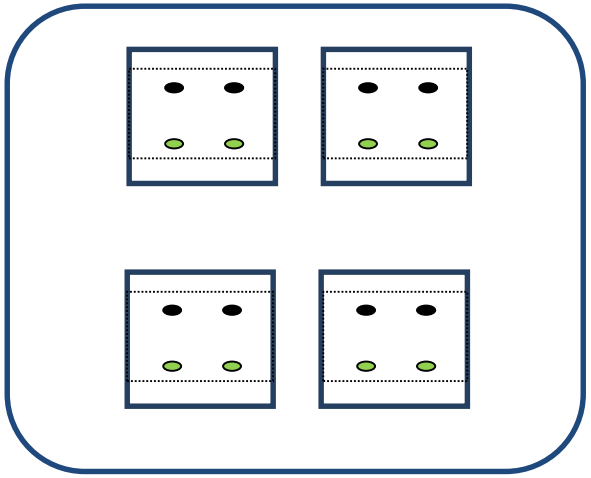
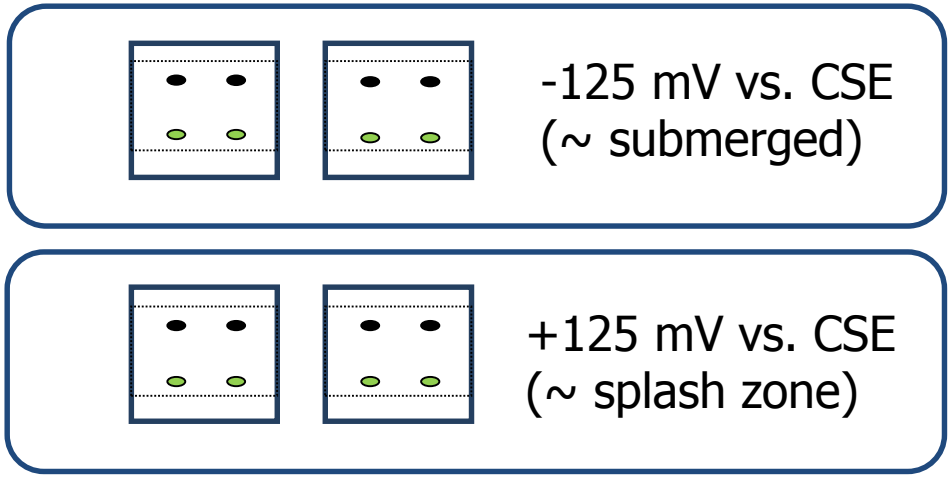
Open circuit setup



Potentiostatic setup (fixed potentials)



- Rebars not treated before casting
- Rebars chemically cleaned in citric acid before casting

Open circuit test setup

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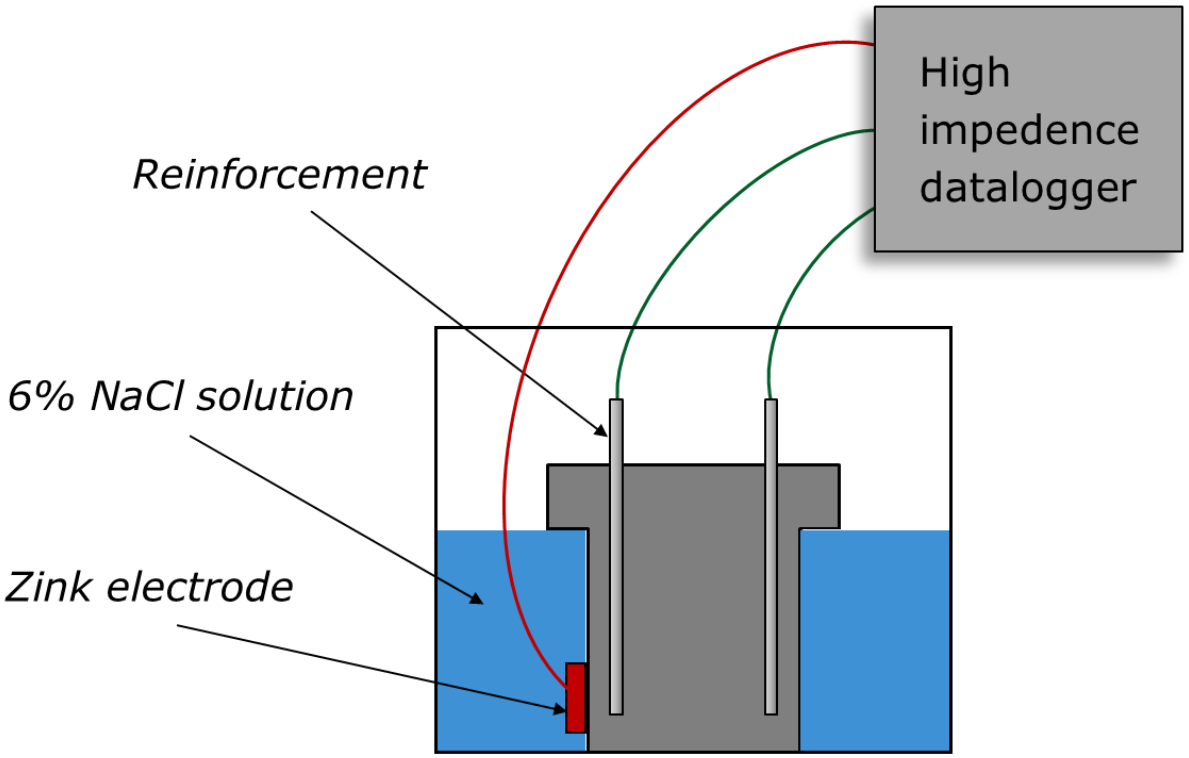

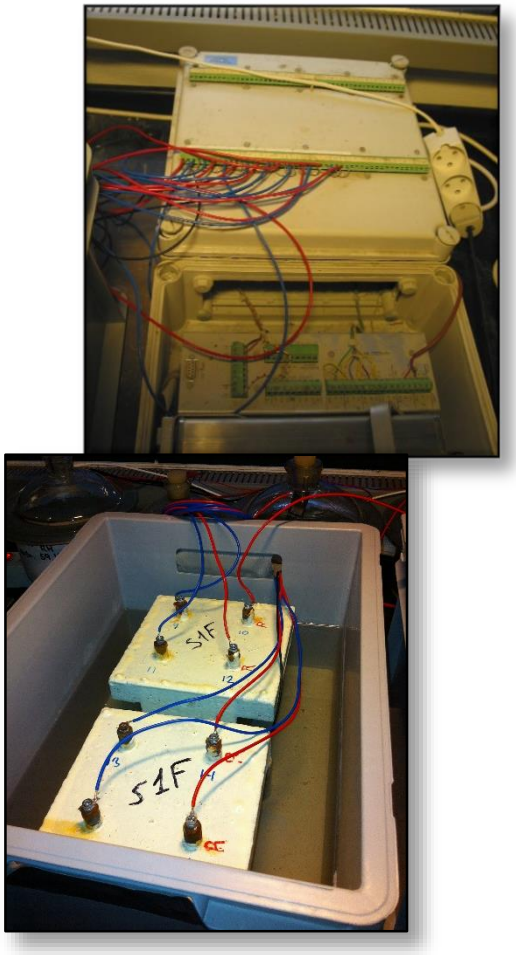

Open circuit setup – Corrosion initiation

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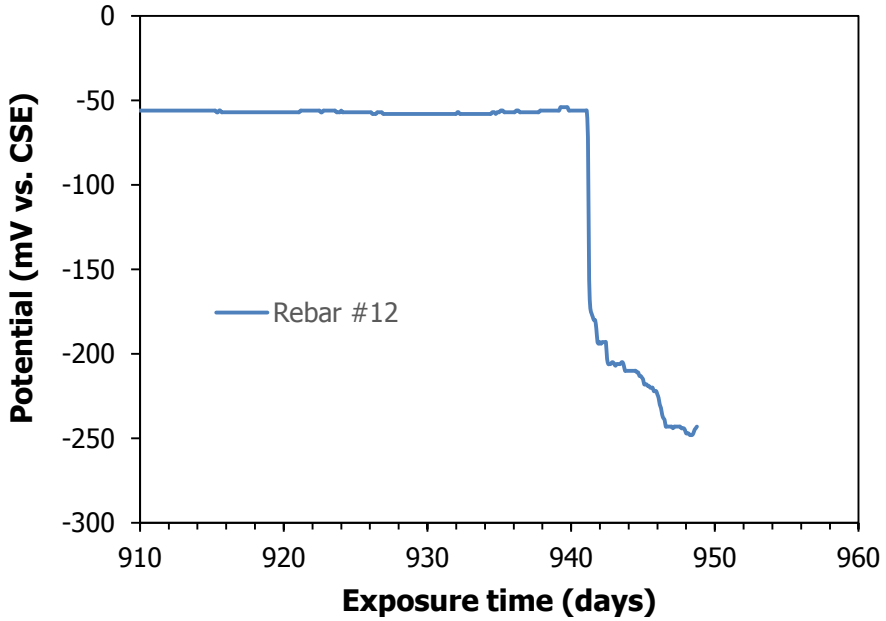
- Corrosion initiation observed in open circuit setup after approx. 940 days of NaCl exposure



Rebar after corrosion initiation

Open circuit setup – Corrosion initiation

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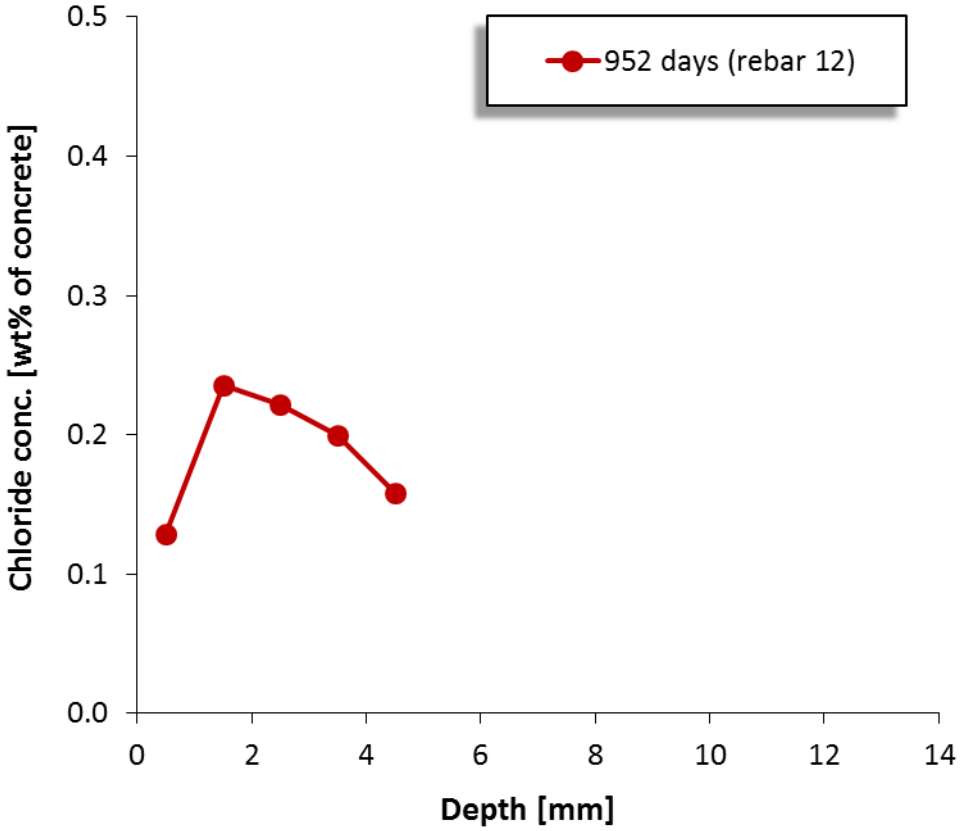

- Chloride threshold value: 0.16 wt% of concrete

Potentiostatic test setup

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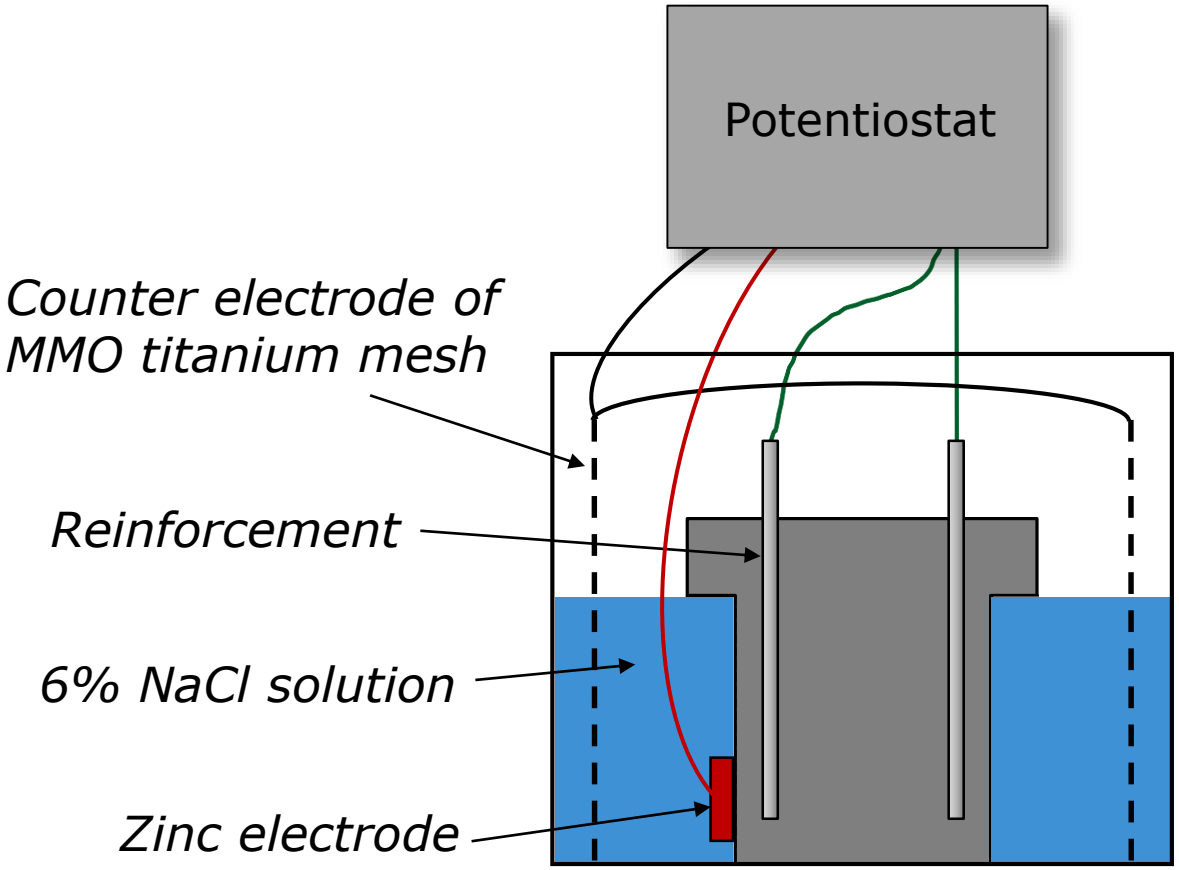
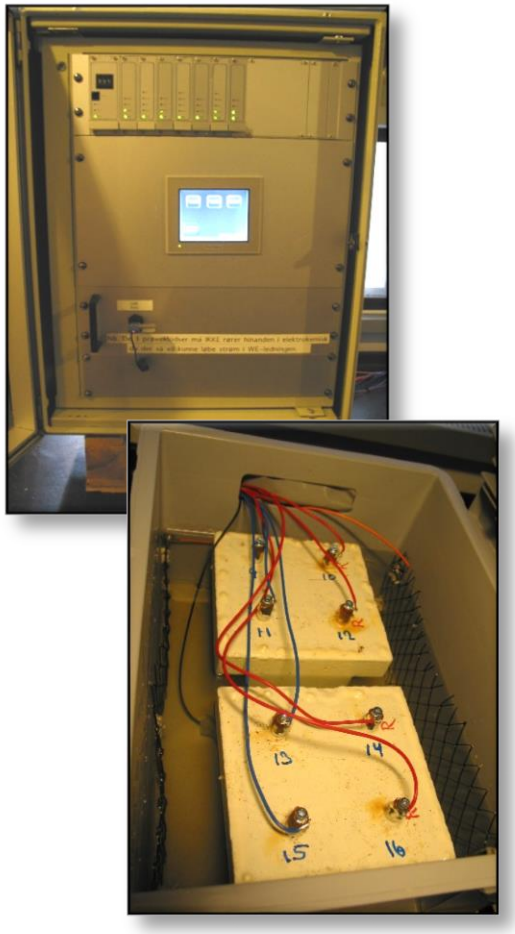
- Registration of corrosion by significant change in current.





Potentiostatic test setup

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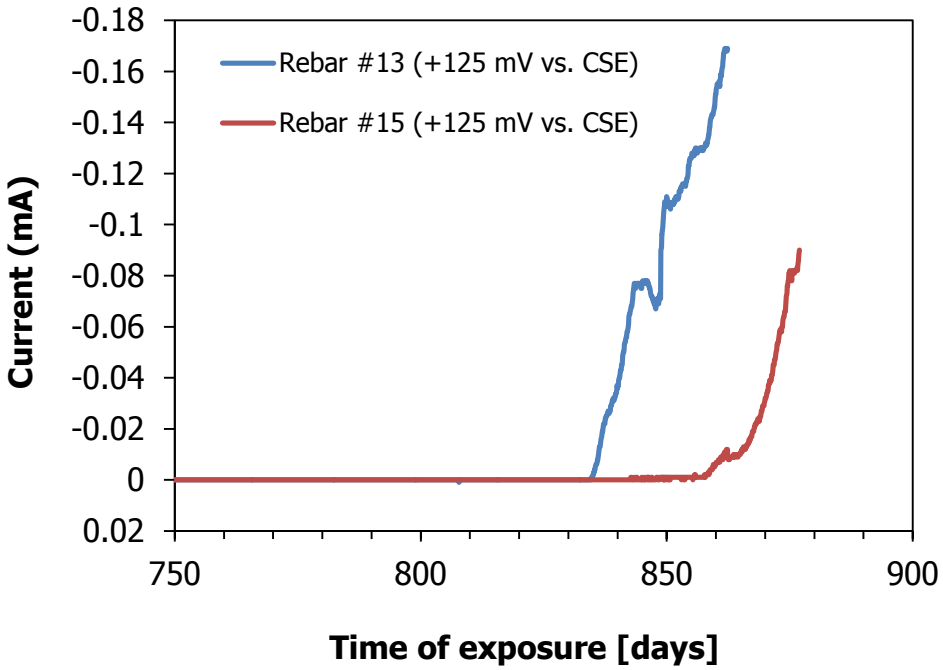
- Onset of corrosion was observed for two rebars in the same specimen after more than 800 days of exposure.
- Rebars disconnected from setup about two weeks after corrosion onset and the chloride contents at rebar depth were determined.



Rebar after corrosion onset

Potentiostatic test setup

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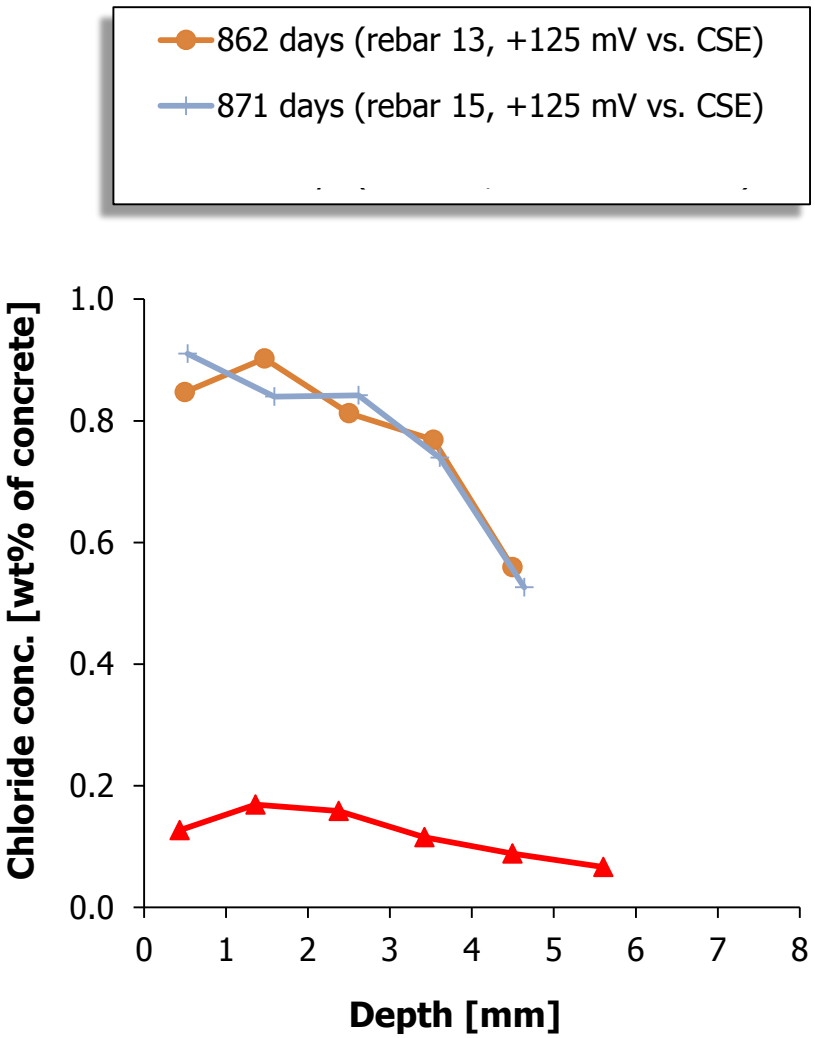

- Corrosion NOT observed at rebar #14, but chloride profile measured anyway

Sample ID	Chloride content at depth of 5 mm [wt% of concrete]
S1P (at rebar no. 13)	0.56
S1P (at rebar no. 15)	0.53
S1P (at rebar no. 14)	0.09

RILEM TC 235-CTC: Corrosion initiating chloride threshold concentrations in concrete

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- Danish Technological Institute is participating in an international Round Robin Test (RRT)
- Purpose of RRT: Test of a newly proposed accelerated in-lab method for determination of chloride threshold values
- Principle: Open circuit measurements on rebars in concrete specimens exposed to a chloride solution
- Includes partial drying of concrete specimens

RILEM TC 235-CTC: Round Robin Test

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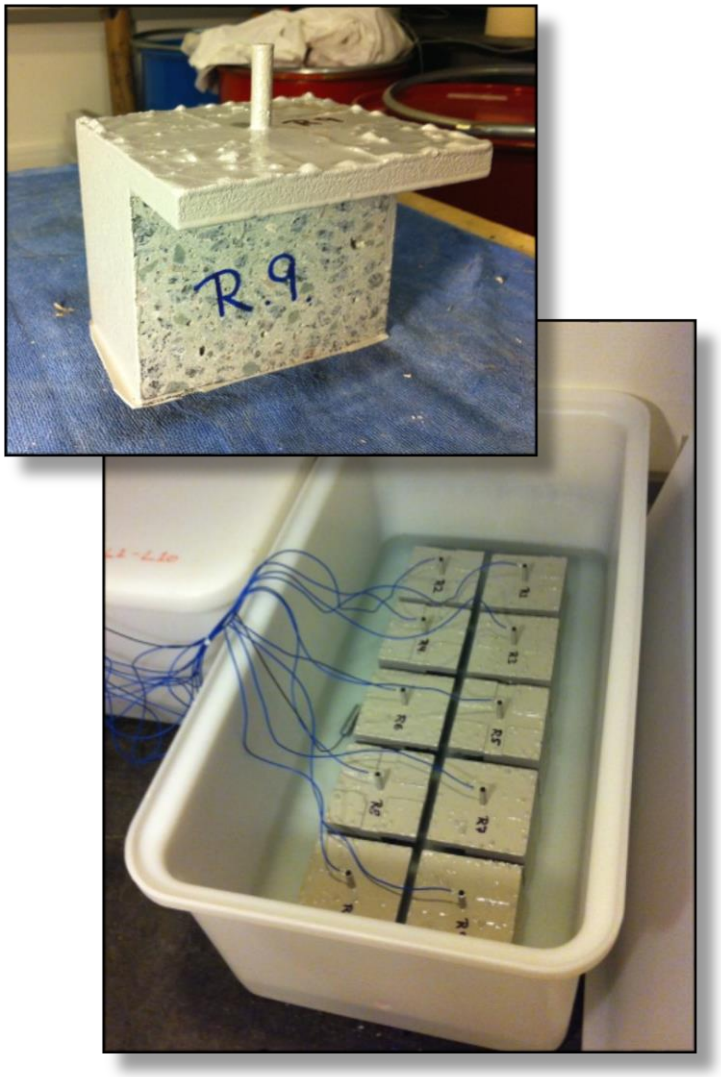

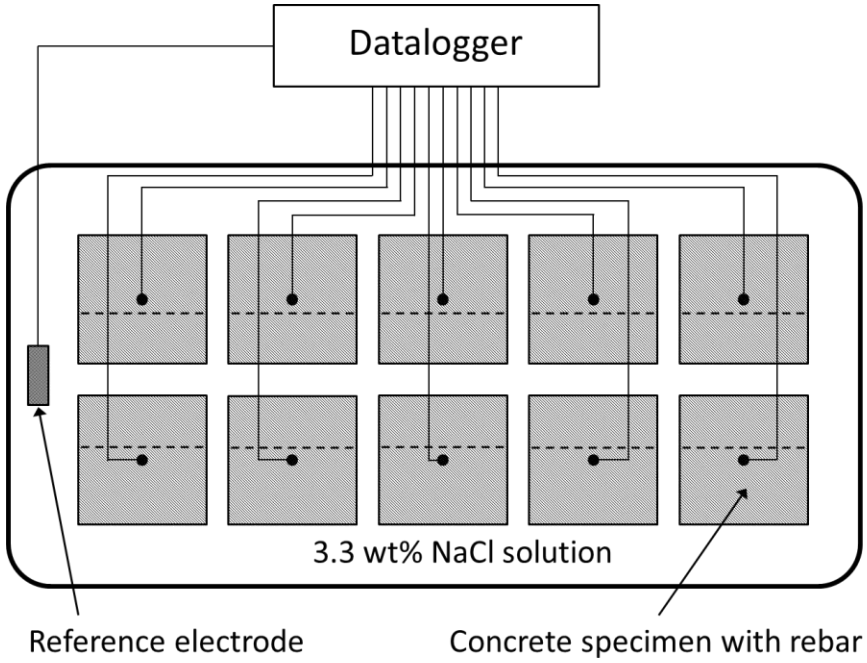

RILEM TC 235-CTC: Round Robin Test

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- So far corrosion initiation has not been observed in spite of prolonged exposure time (> 900 days)
- The general lack of corrosion initiation has also been reported by most of the other participating laboratories

Investigation by microscopy

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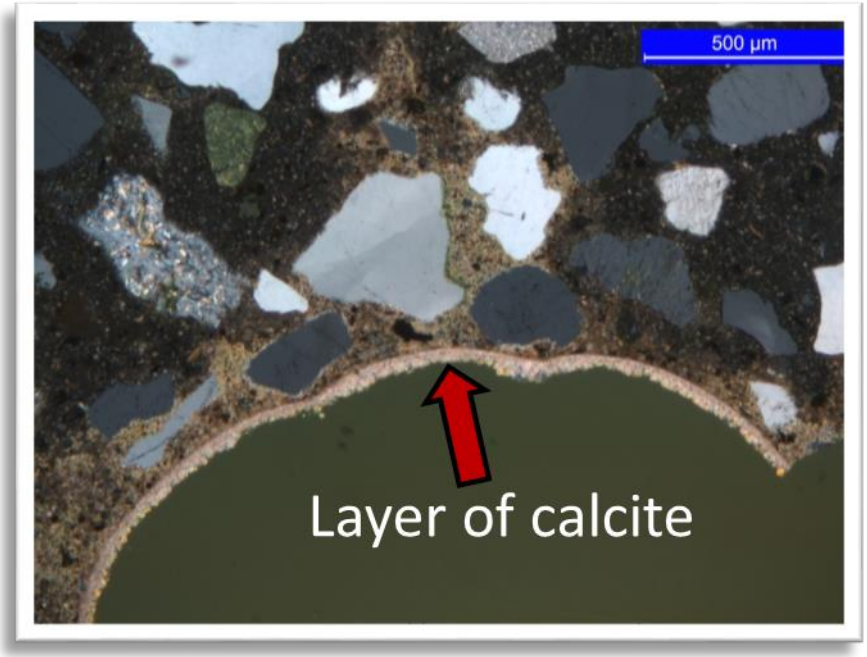
- A few of the exposed concrete specimens were studied by optical microscopy
- Purpose: Try to explain the general lack of corrosion initiation
- A thin and dense crust (~10 μm thick) of calcite were observed at the exposed surface of the investigated specimens



Microphotography:
After 153 days of chloride exposure

Some conclusions

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- A general lack of corrosion initiation has been observed. This was the case both in our own experimental setup as well as in the RILEM Round Robin Test

- A thin crust of calcite was observed on the exposed surface of all concrete specimens investigated by microscopy

- The presented experimental approaches need to be modified somehow in order to become practically applicable for determination of chloride threshold values