DTU Civil Engineering
Department of Civil Engineering

DANISH TECHNOLOGICAL INSTITUTE

CONCRETE EXPERTCENTRE

Chloride threshold values

Meeting with the reference group

12 October 2011

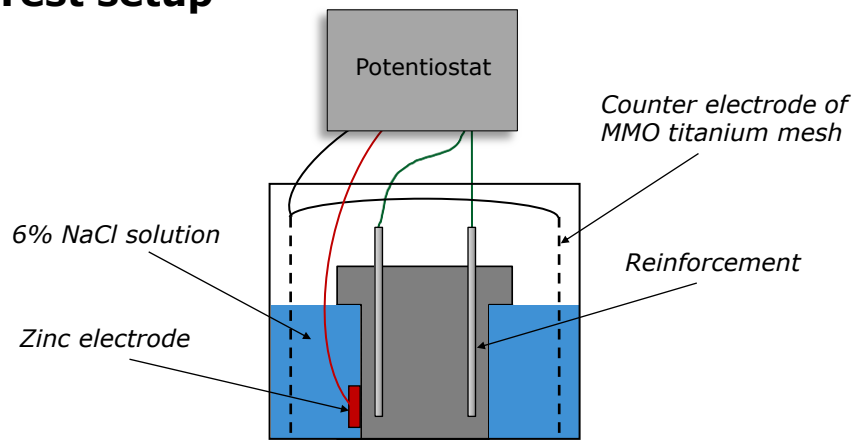
CONCRETE EXPERTCENTRE

Test methods

- Potentiostatic method (fixed potential)
- Free potential method (open circuit)
- RRT with RILEM TC 235 CTC method

Potentiostatic method

Test setup

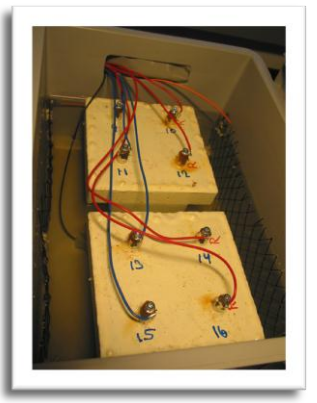


Potentiostatic method

- **Treatment of reinforcement bars:**
  - Pre-rusted
  - Citric acid, then repassivated in $Ca(OH)_2$ solution
- **Potentials representing typical values for:**
  - Seawater splash zone (100mV CSE)
  - Submerged seawater zone (-150mV CSE)

Potentiostatic method

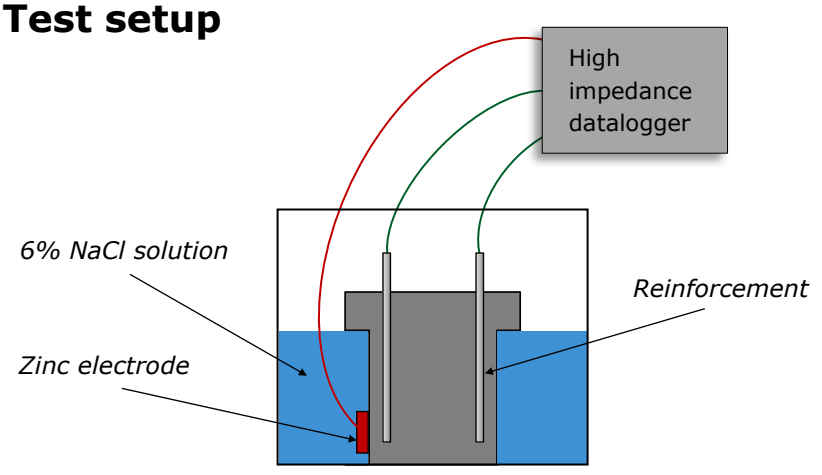
Potentiostat



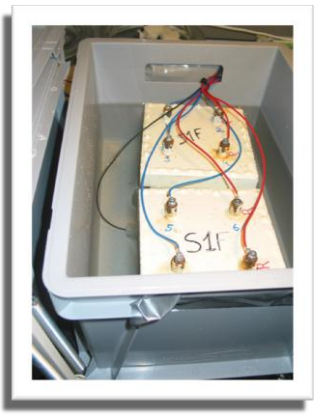
Concrete specimens with rebars and epoxy coating

Free potential method

Test setup



Free potential method



Concrete specimens with rebars and epoxy coating

Datalogger

Concrete mix design

- Powder: Rapid cement (75%) and fly ash (25%)
- Eqv. w/c = 0.45 (w/b = 0.40)
- Aggregate: Granitic (D_{max} = 8 mm)
- No additives in order to know the exact chemistry of the cement paste
- Target slump: 100 – 200 mm

Final mix design

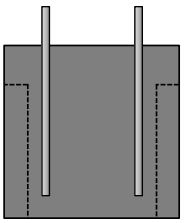
Material	Density	[kg/m^3] SSD	[liter/m^3]
Rapid cement	3160	382	121
Fly ash	2300	127	55
Rønne 0/2 mm	2630	720	274
Rønne 4/8 mm	2710	907	335
Water	1000	200	200
Air			15
Total		2336	1000
Eqv. w/c	0.45		
Slump flow	110 mm		

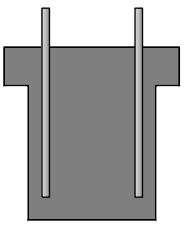
Concrete mixing

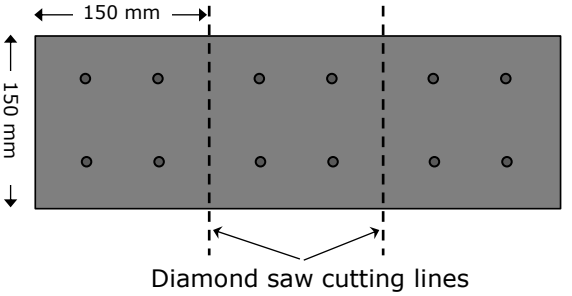
Concrete mixing station

Casting

Cutting



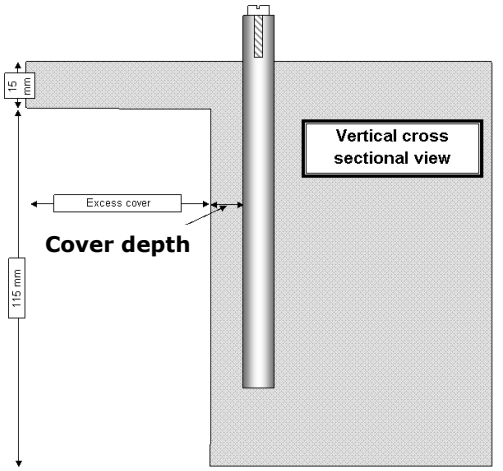




Diamond saw cutting lines

To ensure uni-directional ingress: All surfaces are sealed with epoxy, except the ones to be exposed.

Cutting



Cover depths

- 5 mm
- 15 mm

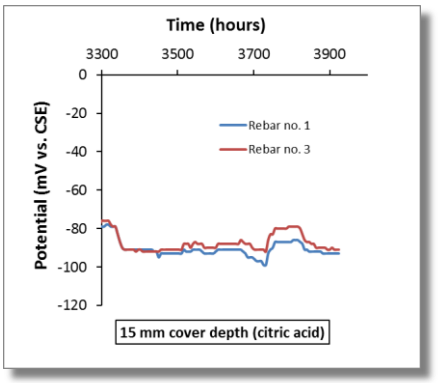
Sample ID and test methods

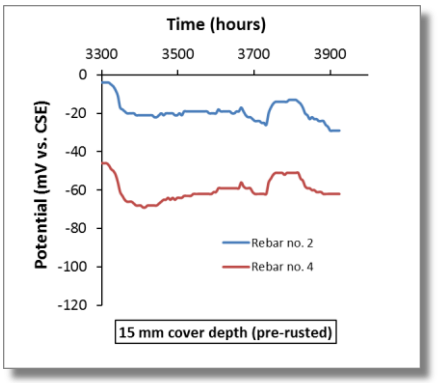
75% Rapid cement + 25% fly ash, eqv. w/c =0.45

	Method						
Sample ID	Free potential	Fixed pot. 100 mV	Fixed pot. -150 mV	Cover depth	Channel no.	Rebar treatment	Date of corrosion initiation
S1F/5/1+3	x			15	1+3	Citric acid	
S1F/5/2+4	x			15	2+4	Rusted	
S1F/5/5+7	x			15	5+7	Citric acid	
S1F/5/6+8	x			15	6+8	Rusted	
S1F/15/1+3	x			5	9+11	Citric acid	
S1F/15/2+4	x			5	10+12	Rusted	
S1F/15/5+7	x			5	13+15	Citric acid	
S1F/15/6+8	x			5	14+16	Rusted	
S1P100/5/1+3		x		5	1+3	Citric acid	
S1P100/5/2+4		x		5	2+4	Rusted	
S1P100/5/5+7		x		5	5+7	Citric acid	
S1P100/5/6+8		x		5	6+8	Rusted	
S1P-150/5/1+3			x	5	1+3	Citric acid	
S1P-150/5/2+4			x	5	2+4	Rusted	
S1P-150/5/5+7			x	5	5+7	Citric acid	
S1P-150/5/6+8			x	5	6+8	Rusted	

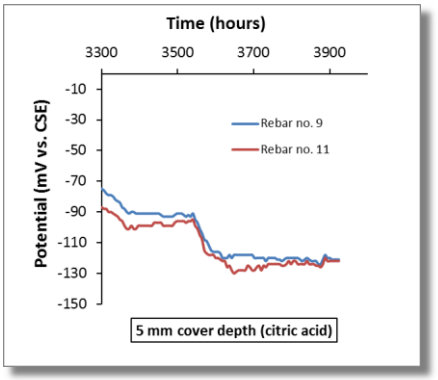
Free potential method

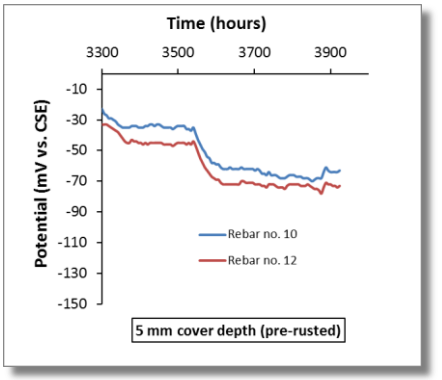
- Corrosion on-set will be detected by significant change in potential
- No indication of corrosion after 5 months of exposure.





Free potential method

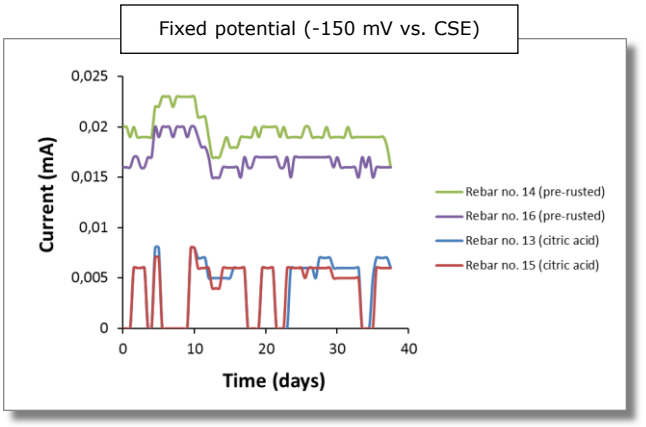




Meeting with reference group of the Expertcentre, DTU Byg, October 12, 2011

Potentiostatic method

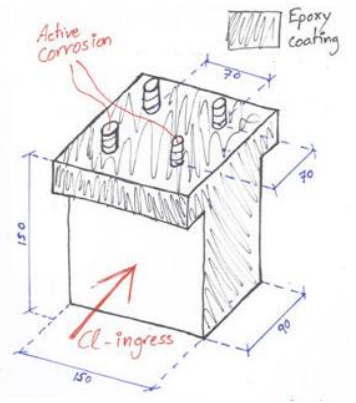
- Corrosion on-set will be detected by significant increase in current
- No indications of corrosion observed after 4 months of exposure

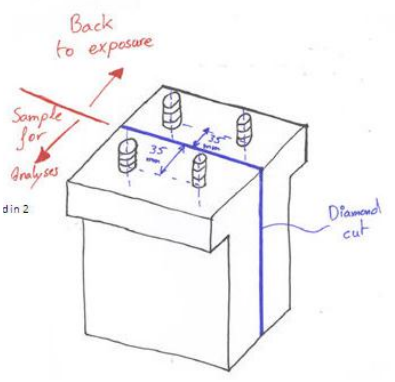


Example of measurements

Chloride profile sampling

Sampling procedure



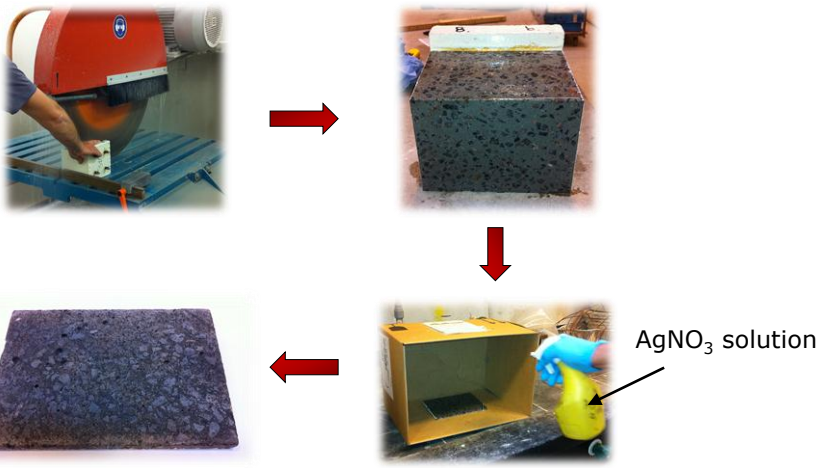


Test of chloride ingress

- No indications of corrosion onset after about 5 months
- Test of chloride ingress:
  - test of chloride ingress with 0.1 M $AgNO_3$ solution (spray-test)
  - two chloride profiles (profile grinding and titration)

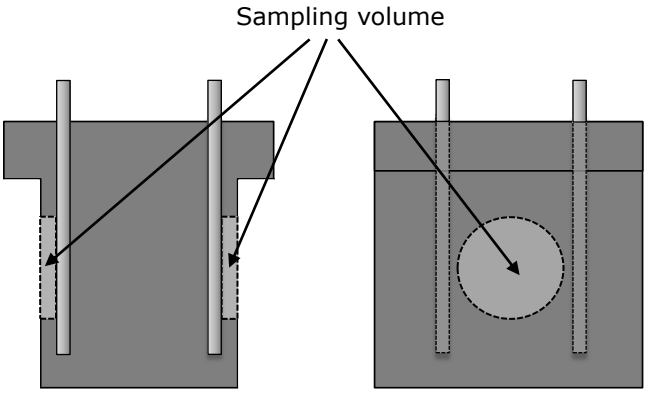
Specimen from free potential setup with 15 mm cover depth

Test of chloride ingress

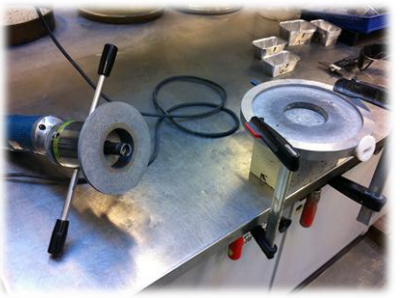


Chloride profile sampling

Cover depth: 15 mm



Chloride profile sampling



- 0 to 5 mm: Sampling in 1 mm intervals
- 5 to 15 mm: Sampling in 2 mm intervals

Chloride profiles

After 153 days of exposure in 6% NaCl solution (at 20°C)