



Langtidsholdbarhed af beton i marint miljø:
Undersøgelse af danske broer

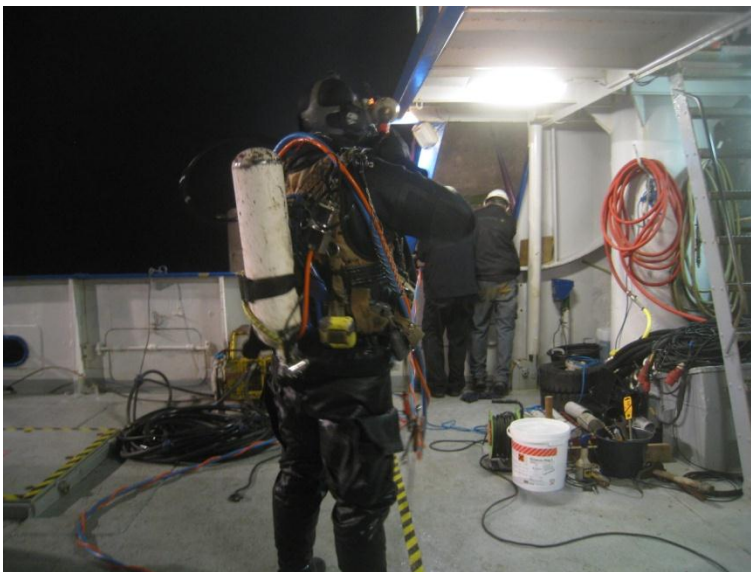
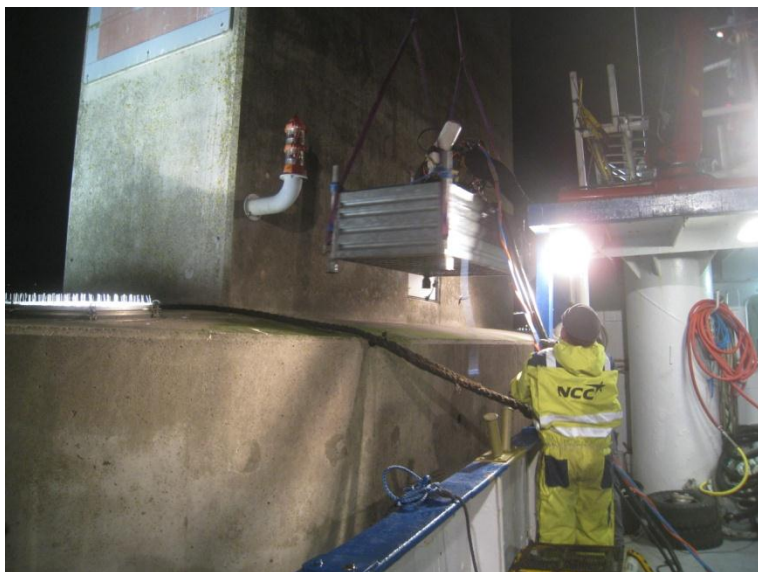
1. Prøveudtagning
2. Chloridindtrængning
3. Mikroskopi og SEM-EDX



Undersøgelsesfartøj



Kerneudboring onder vand



Prøve-numre	Bro	Byggeår	Kote [m]	Udtagnings-dato	Ekspone-ringstid	Bindertype
V1-V4	Vejlefjordbroen	1975-1980	-1,0	18-01-2012	Ca. 34 år	Slaggecement (Aquafirm) fra Tyskland
A1-A4	Alssundbroen	1978-1981	-1,5	17-01-2012	Ca. 31 år	A/L/S-cement fra AaP
F1-F4	Farøbroen	1980-1985	-1,5	03-02-2012	Ca. 30 år	Lavalkali-cement fra AaP + 23% FA fra Danaske
28J-30J	Øresundsbroen	1993-2000	-2,0	08-10-2010	Ca. 12 år	Lavalkali-cement fra Cementa + 4% MS fra Elkem



Kerner fra Vejlefjordbroen



Kerner fra Alssundbroen



Kerner fra Farøbroen

Chloridanalyser

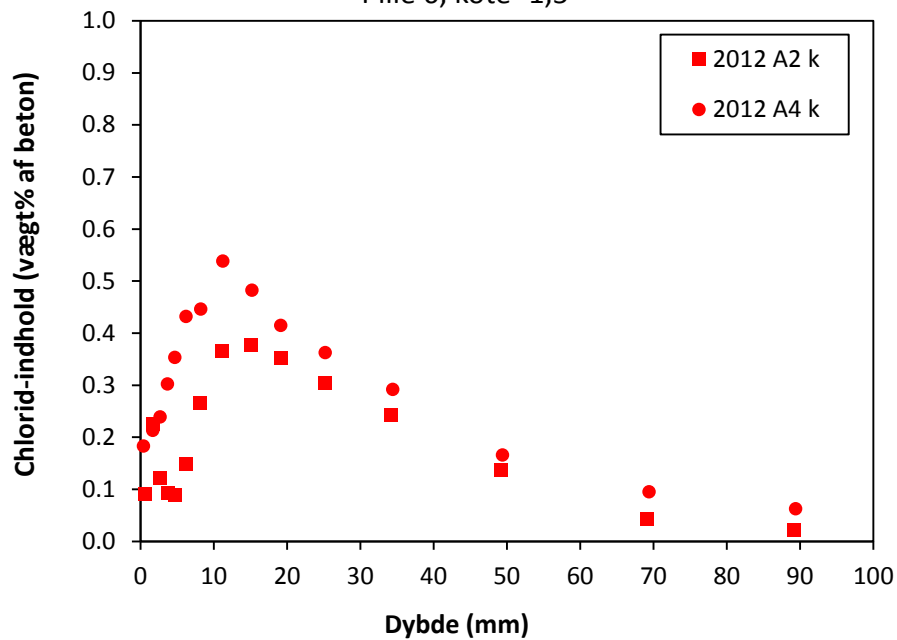


Alssundbroen - chloridprofiler

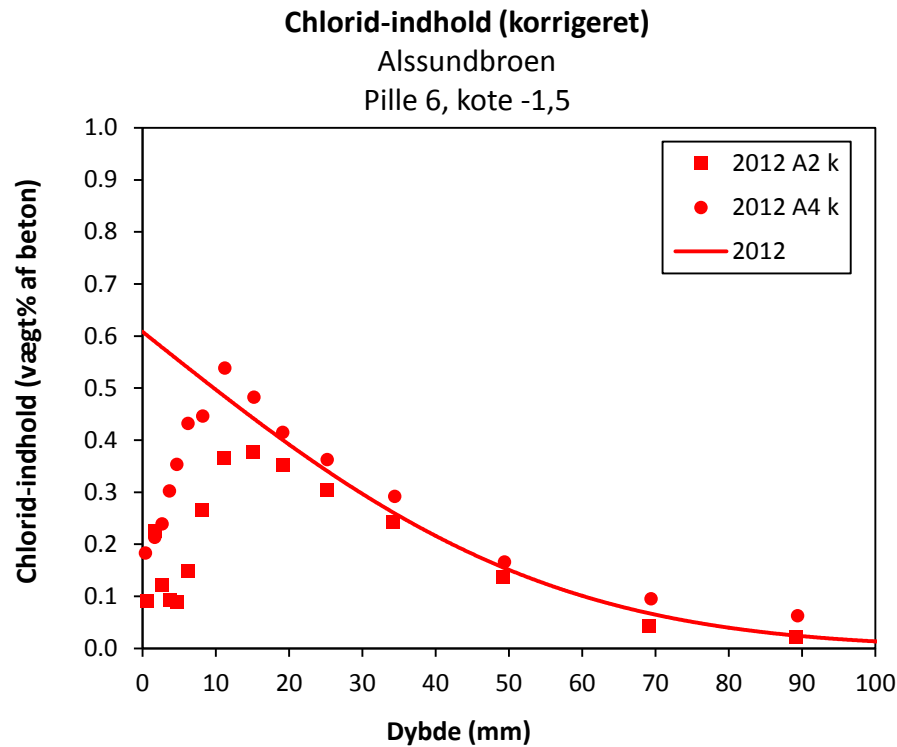
Chlorid-indhold (korrigeret)

Alssundbroen

Pille 6, kote -1,5



Alssundbroen - chloridindtrængningsparametre



$$C(x, t) = C_s - (C_s - C_i) \cdot \operatorname{erf}\left(\frac{x}{\sqrt{4 \cdot D_a \cdot t}}\right)$$

$$K_{0,05} = 2\sqrt{D_a} \cdot \operatorname{erf}^{-1}\left(\frac{C_s - 0,05}{C_s - C_i}\right)$$

År

2012

Enhed

Exp.tid

31

år

D_a

0,95

$\times 10^{-12} \text{ m}^2/\text{s}$

C_s

0,608

vægt% Cl af BE

C_i

0,001

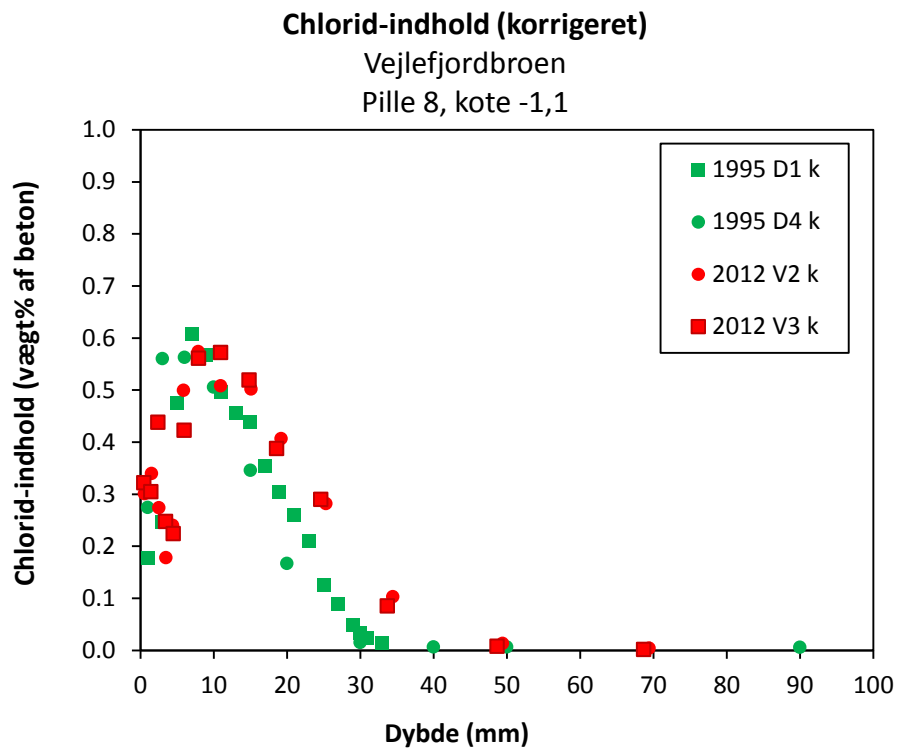
vægt% Cl af BE

$K_{0,05}$

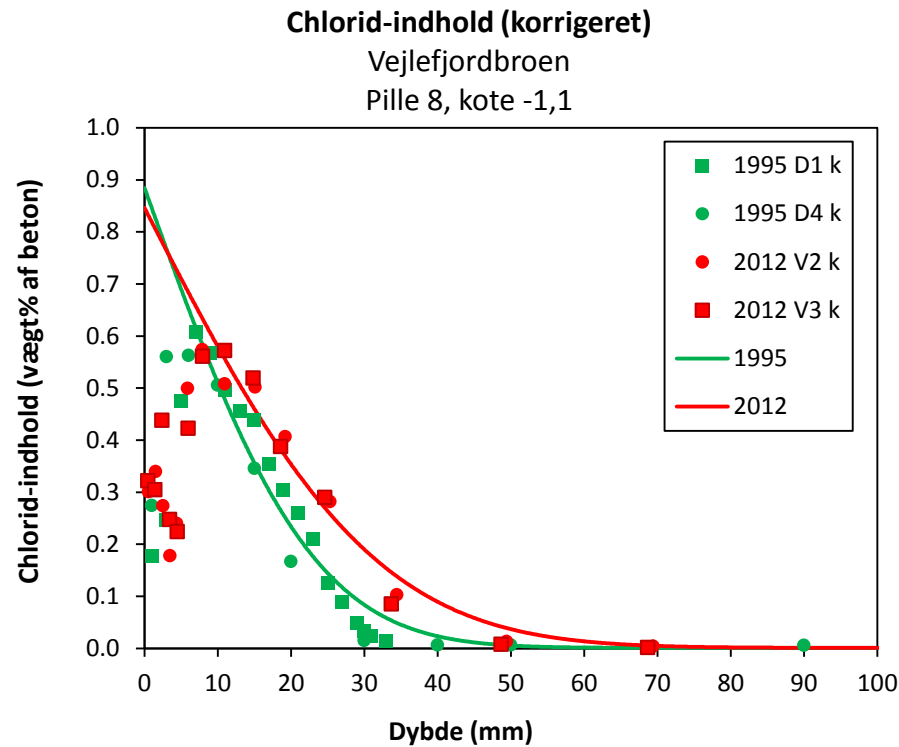
13,5

$\text{mm}/\text{år}^{1/2}$

Vejlefjordbroen - chloridprofiler



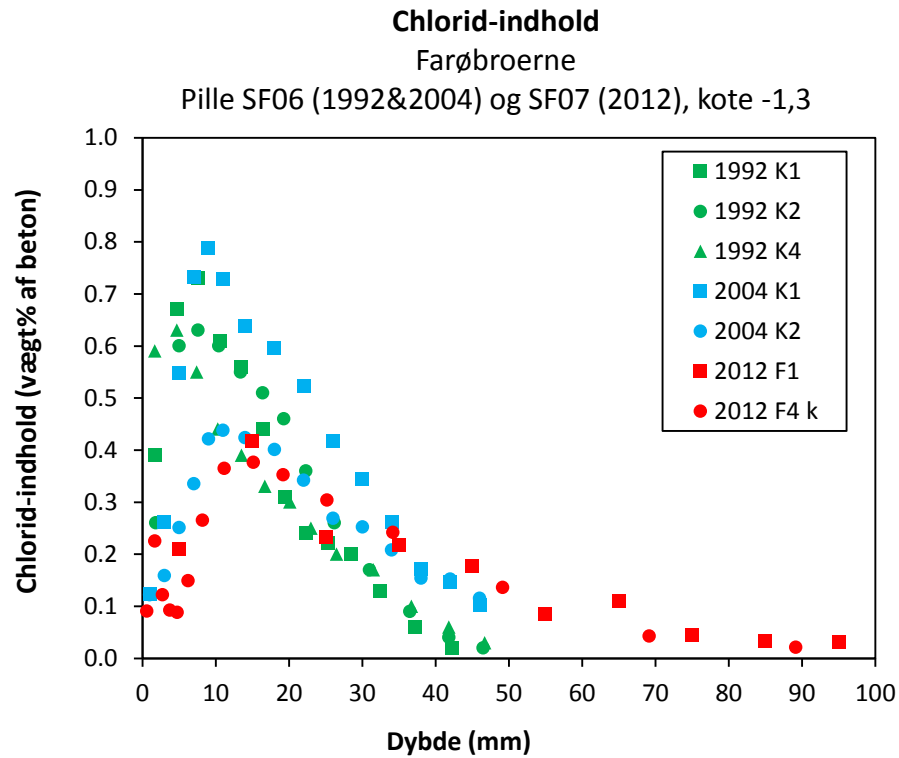
Vejlefjordbroen - chloridindtrængningsparametre



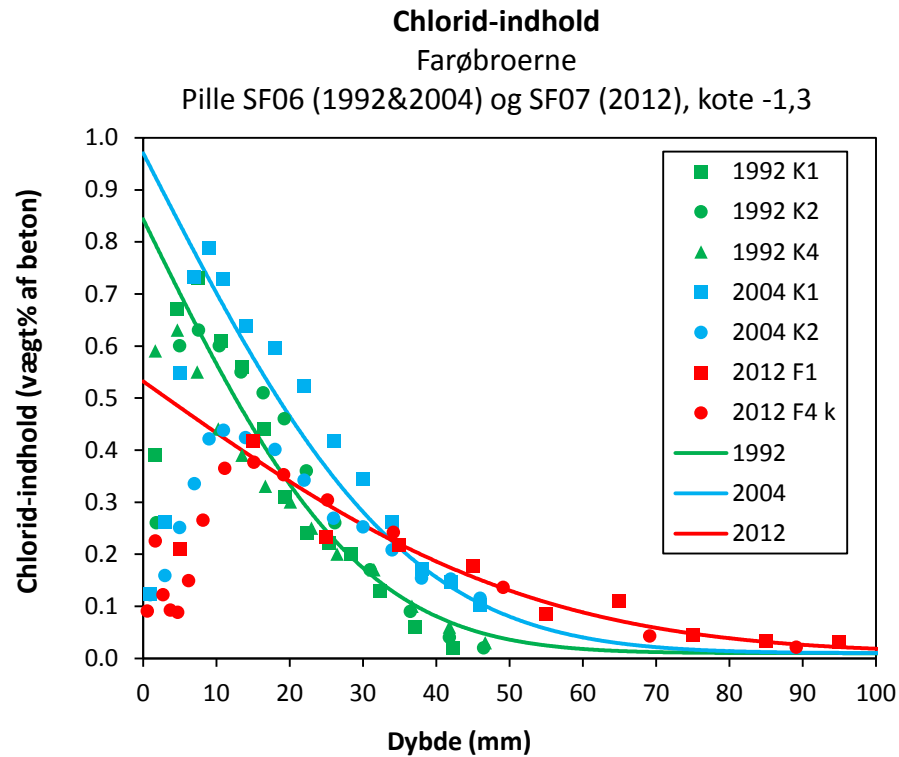
$$C(x, t) = C_s - (C_s - C_i) \cdot \operatorname{erf}\left(\frac{x}{\sqrt{4 \cdot D_a \cdot t}}\right)$$

$$K_{0,05} = 2\sqrt{D_a} \cdot \operatorname{erf}^{-1}\left(\frac{C_s - 0,05}{C_s - C_i}\right)$$

År	1995	2012	Enhed
Exp.tid	17	34	år
D_a	0,30	0,28	$\times 10^{-12} \text{ m}^2/\text{s}$
C_s	0,885	0,846	vægt% Cl af BE
C_i	0,001	0,001	vægt% Cl af BE
$K_{0,05}$	8,3	8,0	$\text{mm}/\text{år}^{1/2}$



Farøbroen - chloridindtrængningsparametre

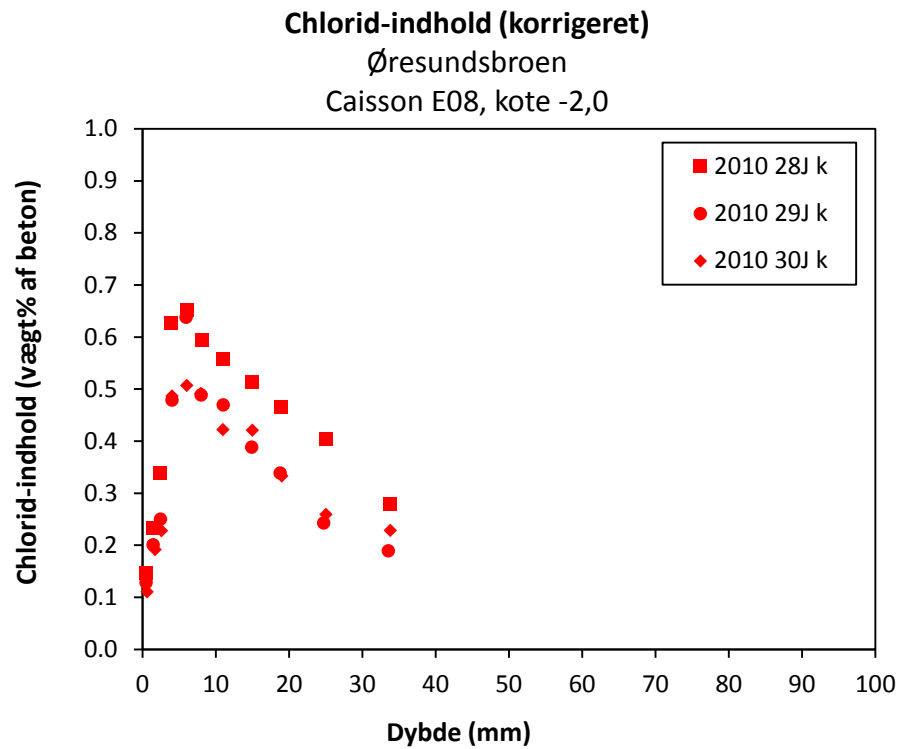


$$C(x, t) = C_s - (C_s - C_i) \cdot \operatorname{erf}\left(\frac{x}{\sqrt{4 \cdot D_a \cdot t}}\right)$$

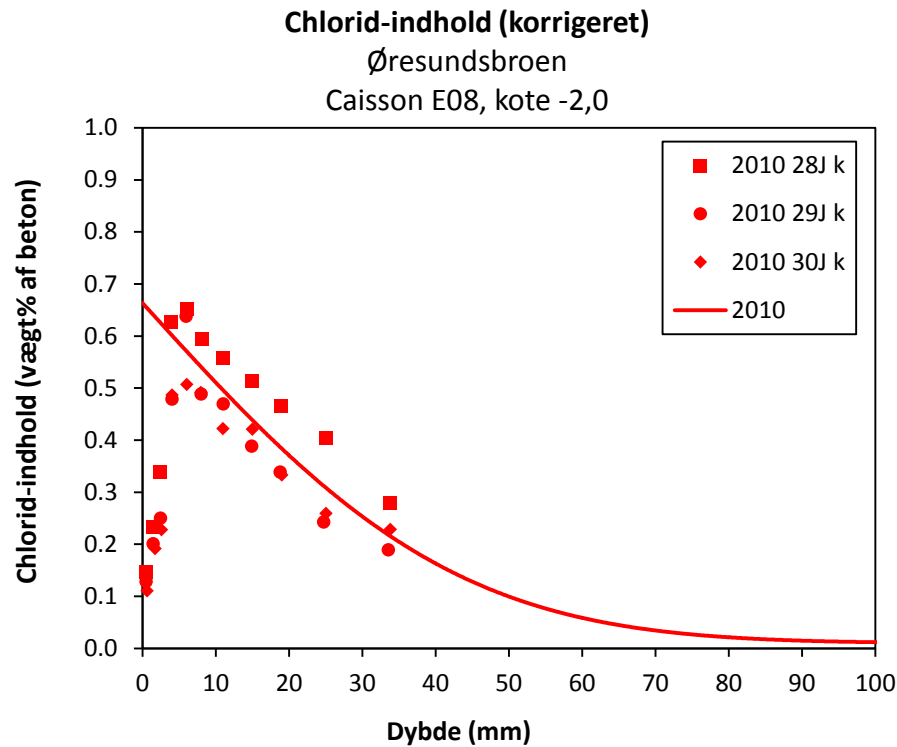
$$K_{0,05} = 2\sqrt{D_a} \cdot \operatorname{erf}^{-1}\left(\frac{C_s - 0,05}{C_s - C_i}\right)$$

År	1992	2004	2012	Enhed
Exp.tid	10,7	22,4	30	år
D_a	0,80	0,55	0,92	$\times 10^{-12} \text{ m}^2/\text{s}$
C_s	0,844	0,971	0,532	vægt% Cl af BE
C_i	0,010	0,010	0,010	vægt% Cl af BE
$K_{0,05}$	14,0	12,0	13,5	$\text{mm}/\text{år}^{1/2}$

Øresundsbroen - chloridprofiler



Øresundsbroen - chloridindtrængningsparametre



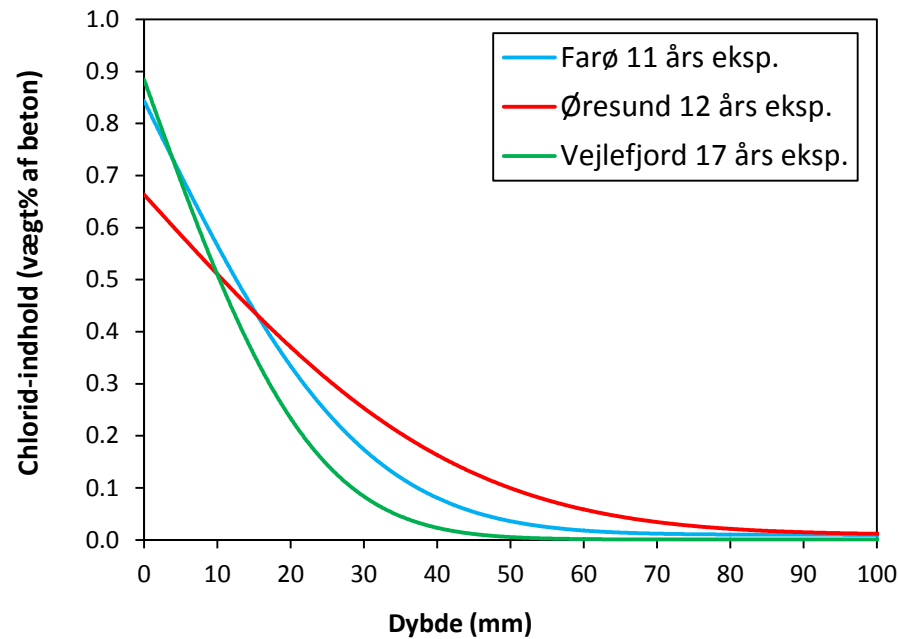
$$C(x, t) = C_s - (C_s - C_i) \cdot \operatorname{erf}\left(\frac{x}{\sqrt{4 \cdot D_a \cdot t}}\right)$$

$$K_{0,05} = 2\sqrt{D_a} \cdot \operatorname{erf}^{-1}\left(\frac{C_s - 0,05}{C_s - C_i}\right)$$

År	2010	Enhed
Exp.tid	12	år
D_a	1,50	$\times 10^{-12} \text{ m}^2/\text{s}$
C_s	0,663	vægt% Cl af BE
C_i	0,010	vægt% Cl af BE
$K_{0,05}$	18,2	$\text{mm}/\text{år}^{1/2}$

Chloridindtrængning efter 11-17 år – 3 broer

Chloridprofiler
3 broer, kote -1 til -2



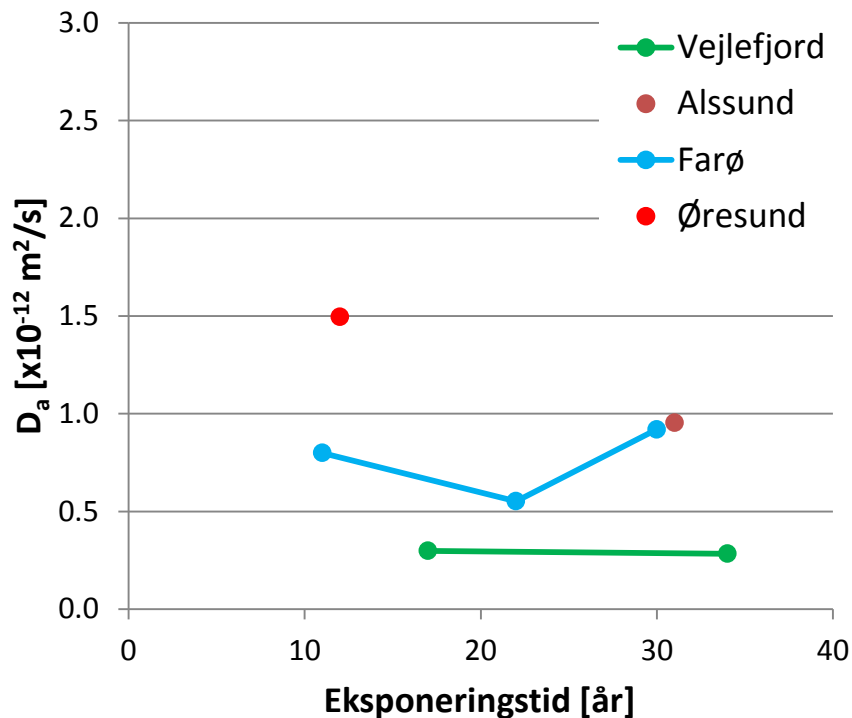
$$C(x, t) = C_s - (C_s - C_i) \cdot \operatorname{erf}\left(\frac{x}{\sqrt{4 \cdot D_a \cdot t}}\right)$$

$$K_{0,05} = 2\sqrt{D_a} \cdot \operatorname{erf}^{-1}\left(\frac{C_s - 0,05}{C_s - C_i}\right)$$

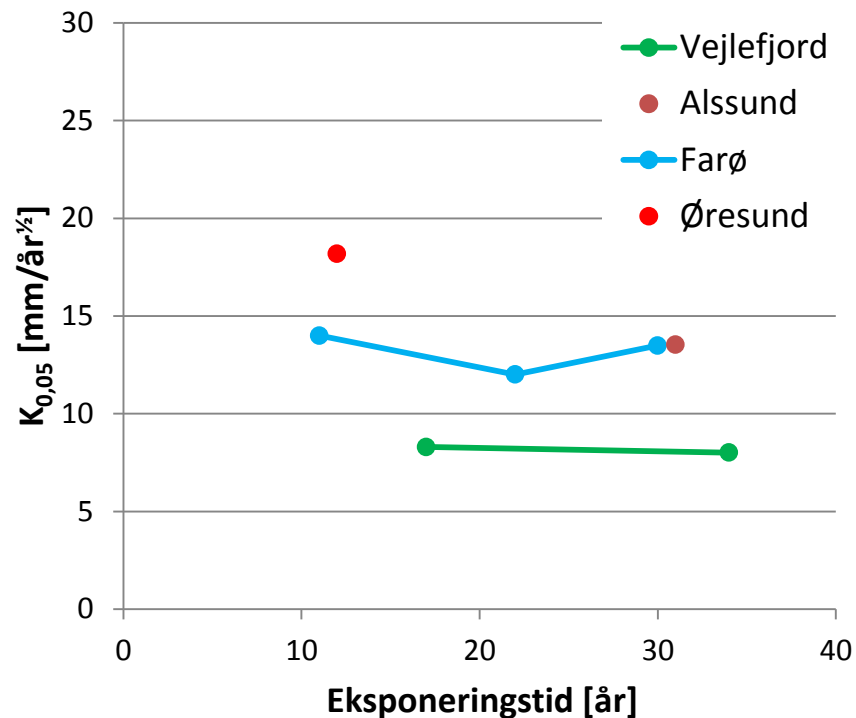
	Farø	Øresund	Vejlefjord	Enhed
Exp.tid	11	12	17	år
D_a	0,80	1,50	0,30	$\times 10^{-12} \text{ m}^2/\text{s}$
C_s	0,844	0,663	0,885	vægt% Cl af BE
C_i	0,010	0,010	0,001	vægt% Cl af BE
$K_{0,05}$	14,0	18,2	8,3	$\text{mm}/\text{år}^{\frac{1}{2}}$

Chloridindtrængningsparametre – 4 broer

Diffusionskoefficienten D_a



Indtrængningsparameteren $K_{0,05}$



$$C(x, t) = C_s - (C_s - C_i) \cdot \operatorname{erf} \left(\frac{x}{\sqrt{4 \cdot D_a \cdot t}} \right)$$

$$K_{0,05} = 2\sqrt{D_a} \cdot \operatorname{erf}^{-1} \left(\frac{C_s - 0,05}{C_s - C_i} \right)$$

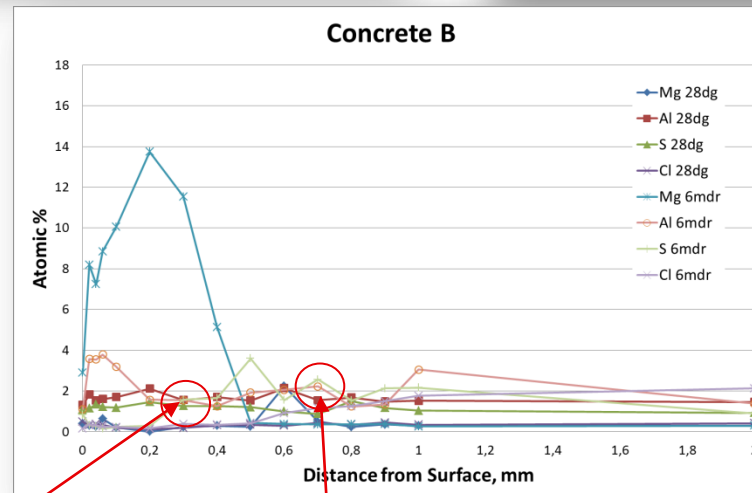
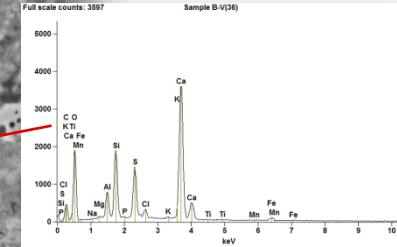
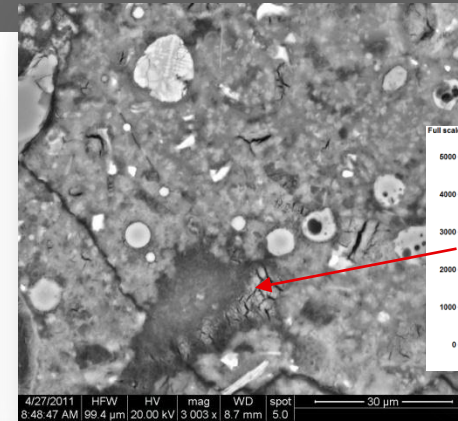
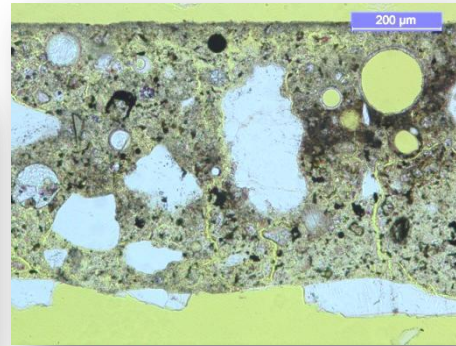
Der ses ikke en tidsafhængig diffusionskoefficient som f.eks.

$$D_a(t) = D_{aex} \left(\frac{t_{ex}}{t} \right)^\alpha$$

i de to tilfælde, hvor der efter de første 10 års eksponering er målt til mere en 1 termin



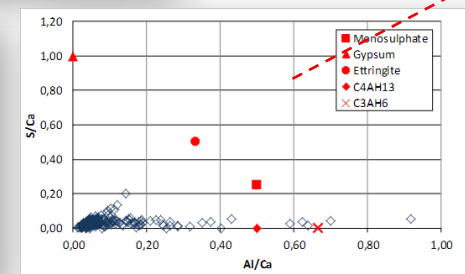
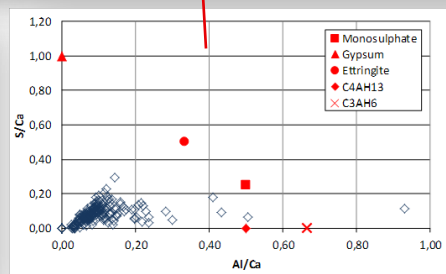
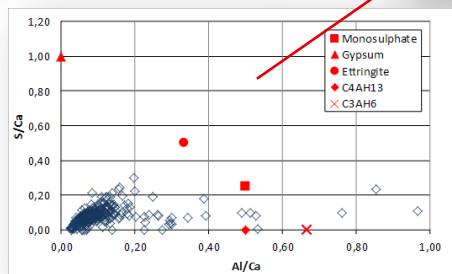
Mikroskopi og SEM-EDX



Macro-analysis: Crack pattern, homogeneity...

Micro-analysis - OPM: Paste porosity, leaching, carbonation, precipitates, micro-cracks ...

SEM-EDX: Structural analysis, chemical trends, phase identification, phase analysis ...



Fremgangsmåde ved SEM-EDX-målingerne

- I hvert dybdeniveau udføres 300 punktanalyser, som er fordelt over 3 analysefelter (fig. 1), som hver består af 10x10 punkter fordelt over et areal svarende til billedarealet ved ca. 1500x forstørrelse (fig. 2).
- De tre felter fordeles på tværs af prøven, og placeres så vidt muligt uden om tilslag og luftporer.

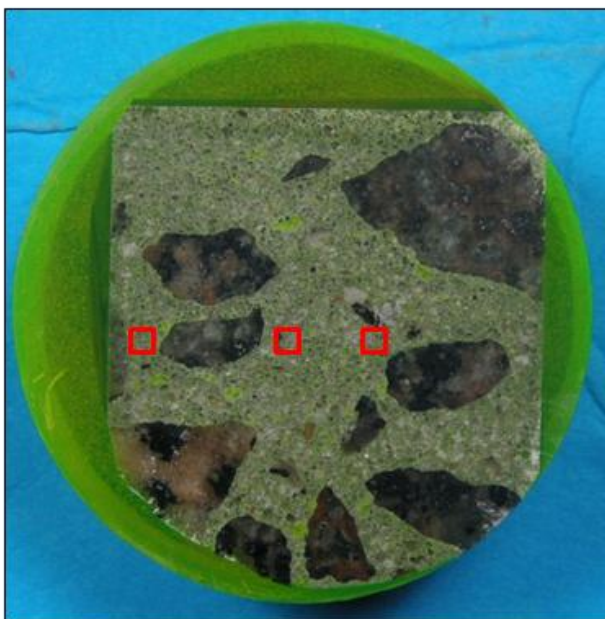


Fig. 1: Eksempel på fordeling af de 3 analysefelter i et bestemt niveau

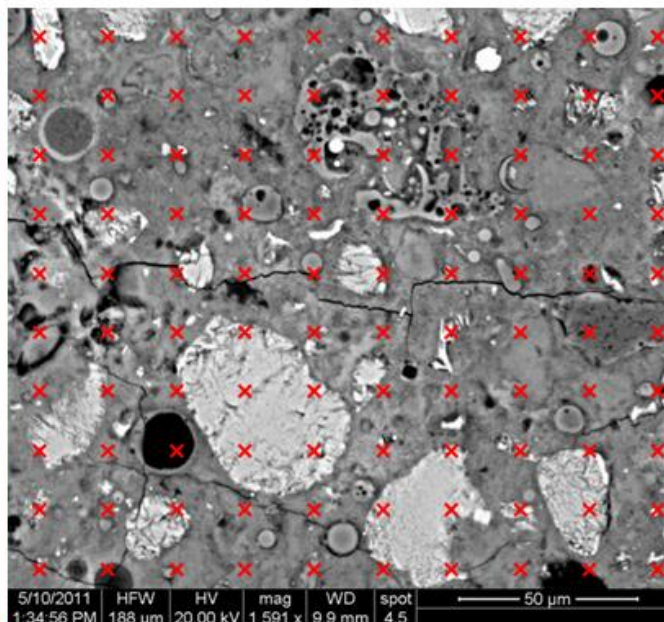


Fig. 2: Eksempel på et analysefelt, som består af 10x10 punkter.

Mikroskopi og SEM-EDX – gamle broer

Bro	Bygget	Udtagningsdato	Udtagningssted	Kote/Niveau	Prøvenr.	Cement	Tyndslib		Polerprøve		Chlorid	
						Type	Top	Bund	Top	Bund	Dybde	Mass%
Gl Lillebælt	1929-35	sep-10	Pille 3 vandfyldt celle 17	Gulv	Niras 640	PC	-	-	0-45	100-140	0-30	0,29
Gl Lillebælt	1929-35	dec-10	Pille 3 vandfyldt celle 19	4	Niras 607	PC	-	-	-	50-100	0-30	0,42
Gl Lillebælt	1929-35	dec-10	Pille 3 vandfyldt celle 19	4	Niras 608	PC	-	-	-	40-75	0-30	0,40
Gl Lillebælt	1929-35	dec-10	Pille 3 vandfyldt celle 18	4	Niras 626	PC	-	-	0-45	-	0-30	0,35
Gl Lillebælt	1929-35	dec-10	Pille 3 vandfyldt celle 18	4	Niras 627	PC	-	-	0-45	45-90	0-30	0,41
Gl Lillebælt	1929-35	dec-10	Pille 3 vandfyldt celle 18	4	Niras 628	PC	-	-	0-45	-	0-30	0,41
Gl Lillebælt	1929-35	dec-10	Pille 3 vandfyldt celle 18	4	Niras 629	PC	-	-	-	30-75	0-30	0,41
Vejlefjord	1975-80	okt-96	Pille 8, sydside	+35	Niras 681-1	PC	x	x	-	-		
Vejlefjord	1975-80	okt-96	Pille 8, sydside	-149	Niras 681-3	Slagge	x	x	-	-		
Vejlefjord	1975-80	okt-96	Pille 8, sydside	-265	Niras 681-4	Slagge	x	x	-	-		
Vejlefjord	1975-80	dec-95	Pille 13, vestside	+1,3m	Niras 660-1 (4)	Slagge	x	x	-	-		
Vejlefjord	1975-80	dec-95	Pille 13, vestside	+1,4m	Niras 660-2 (15)	Slagge	x	x	-	-		
Gl Lillebælt	1929-35	okt-11	Pille 4, vandfyldt celle 20-22	4V_05	LB-1	PC	-	-			0-200	
Gl Lillebælt	1929-35	okt-11	Pille 4, vandfyldt celle 17-19	4V_06	LB-2	PC	A,B	C	A,B	C	-	
Gl Lillebælt	1929-35	okt-11	Pille 4, tør, celle 18	4T-01	LB-3	PC	A,B	C	A,B	C	-	
Gl Lillebælt	1929-35	okt-11	Pille 4, tør, celle 17	4T-02	LB-4	PC	A	C	A	C	0-200	
Gl Lillebælt	1929-35	okt-11	Pille 4, tør, celle 1-2	4T_03	LB-5	PC	A,B	C	A,B	C	-	
Gl Lillebælt	1929-35	okt-11	Pille 4, tør, celle 3-1	4T_04	LB-6	PC	A	-	A	-	0-200	
Gl Lillebælt	1929-35	okt-11	Pille 4, vandfyldt celle 5	4V_03	LB-7	PC	-	C	-	C	0-200	
Gl Lillebælt	1929-35	okt-11	Pille 4, vandfyldt celle 5	4V_04	LB-8	PC	A,B	C	A,B	C	-	
Gl Lillebælt	1929-35	okt-11	Pille 4, tør	1	LB-9	PC	A	-	A	-	10-12, 20-22, 36-38	
Alssundbroen	1978-81	jan-12	Piller, under vand	-1,5m	A3	PC (LavAlk)	A	-	A,B	-		
Vejlefjordbroen	1975-80	jan-12	Piller, under vand	-1m	V1	Slagge, lav CH	A	-	A,B	-		
Farøbroen	1980-85	feb-12	Piller, under vand	-1,5m	F3	PC (LavAlk)+23%FA	A	-	A,B	-		
Stormstrømsbroen	1933-37	jan-12	Piller, under vand	-7.3 til -7.5	Rambøll 7UV	PC, 1:2:3			0-45			
Stormstrømsbroen	1933-37	jan-12	Piller, under vand	-6.1 til -6.7	Rambøll 12UV V	PC, 1:2:3			0-45			
Stormstrømsbroen	1933-37	jan-12	Piller, under vand	-1.1	Rambøll 33UV top	PC, 1:2:3			0-45			
Øresundsbroen	1998 (juli)	nov-10	Pille, over vand		F16 (7090)	SE lavAlk+MS			A			
Øresundsbroen	1998 (juli)	nov-10	Pille, over vand		F17 (7090)	SE lavAlk+MS			A			
Øresundsbroen	1997 (nov)	nov-10	Pille, over vand		H23 (7090)	SE lavAlk+MS			A			
Øresundsbroen	1997 (juli)	nov-10	Pille, under vand	-2m	J28 (7090)	SE lavAlk+MS			A			

Young concrete: Femern trial concrete (28 maturity age, 6 & 24 months)

- A** Portland low alkali sulfate resistant cement (CEM I 42,5 N) w/c=0.40.
- B** CEM I 42,5 N with 15% fly ash, w/c=0.40.
- C** CEM I 42,5 N with 25% fly ash, w/c=0.40.
- D** CEM I 42,5 N with 25% fly ash, SCC, w/c=0.40.
- E** CEM I 42,5 N with 4% silica fume, w/c=0.40.
- F** CEM I 42,5 N with 12% fly ash and 4% silica fume, w/c=0.40.
- G** CEM I 42,5 N with 12% fly ash and 4% silica fume, no air entrainment, w/c=0.40.
- H** CEM I 42,5 N with 12% fly ash and 4% silica fume, w/c=0.45.
- I** CEM I 42,5 N with 12% fly ash and 4% silica fume, w/c=0.35.
- J** CEM I 42,5 N with 12% fly ash and 4% silica fume, SCC, w/c=0.40.
- K** Traditional slag cement (CEM III/B), w/c=0.40.
- L** CEM III/B, no air entrainment, w/c=0.40.
- M** CEM III/B, SCC, w/c=0.40.
- N** 70 % slag mixed with 30% rapid cement (CEM I 52,5 N) w/c=0.40.
- O** CEM I 42,5 N with 4% silica fume with super absorbing polymers, w/c=0.40.

Basis cement (CEM II, 52.5 – containing <5% LF and FA)

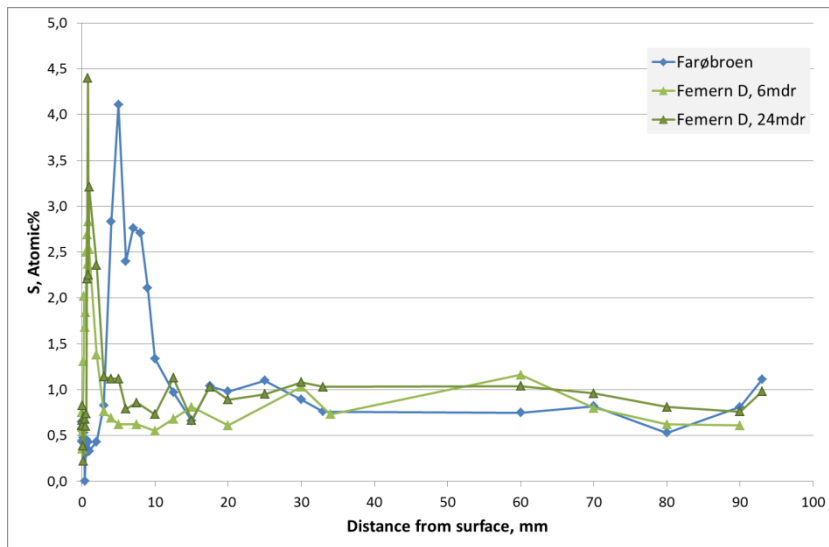
Rapid hardening cement (CEM I 52.5 LA/MS)

Rapid hardening cement (CEM I 52.5 LA/MS) with 30% fly ash

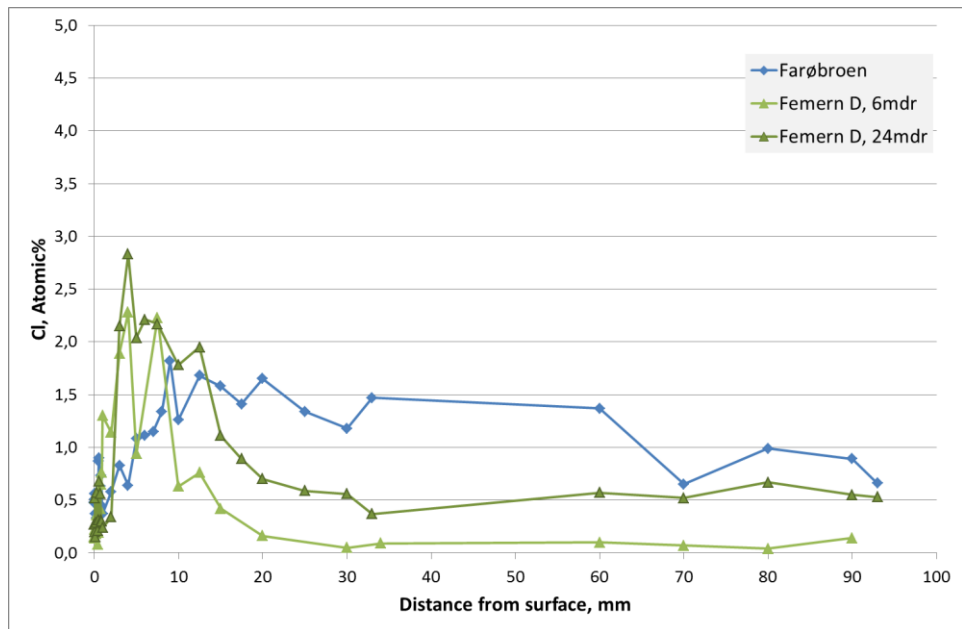
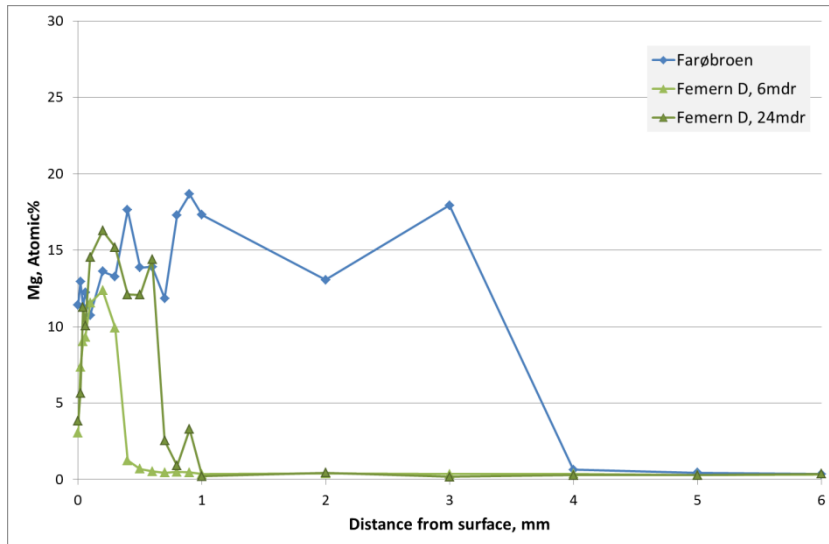
Rød – 28 døgn, 6 mdr, 2 år

Sort – kun 28 døgn

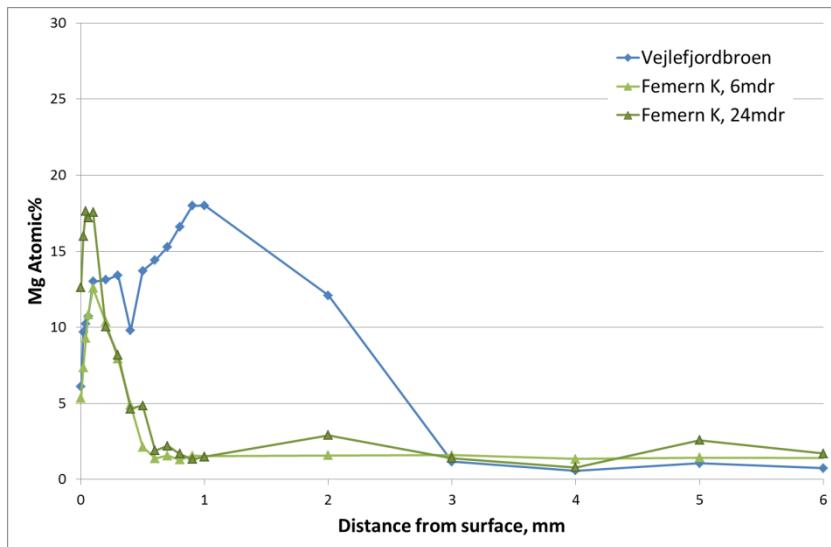
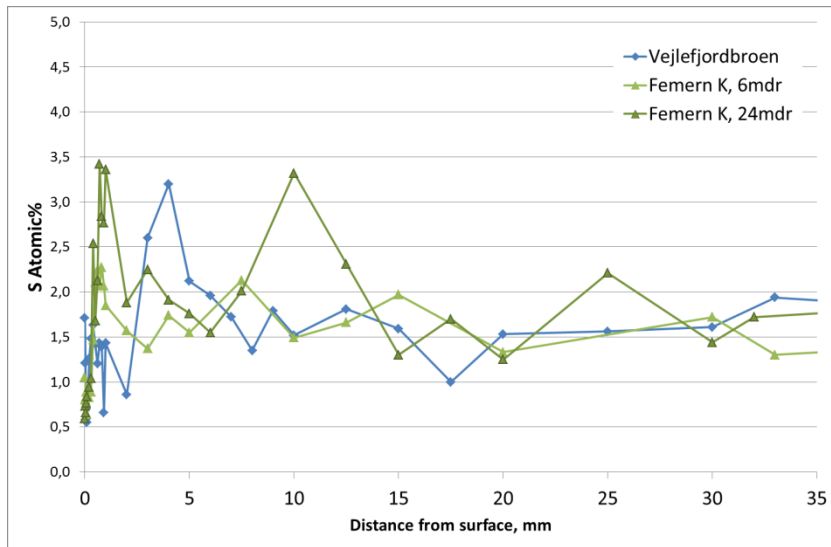
Farøbroen og Femern D – SEM-EDX



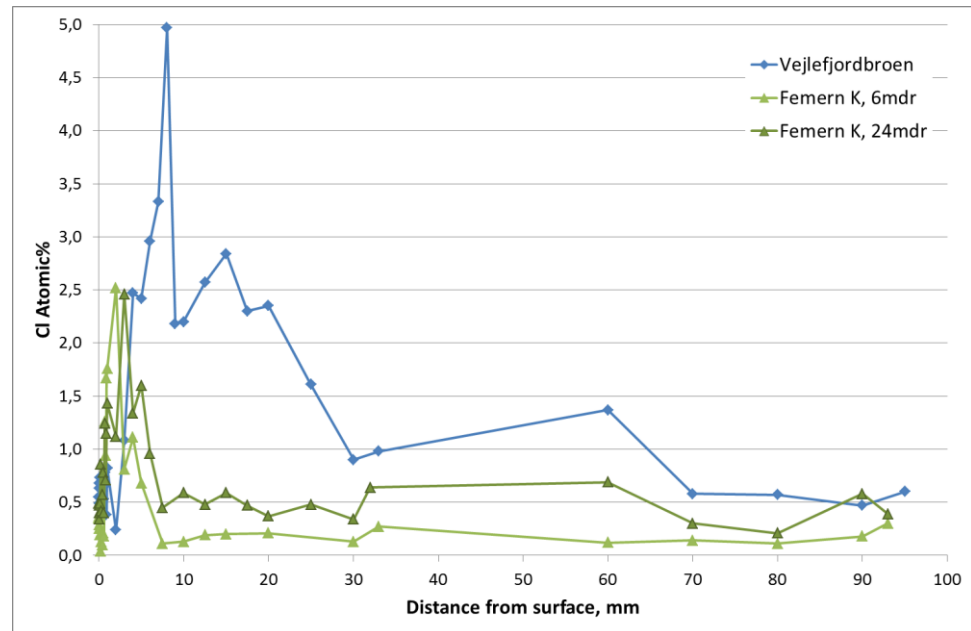
Tidsmæssig variation af S, Mg og Cl



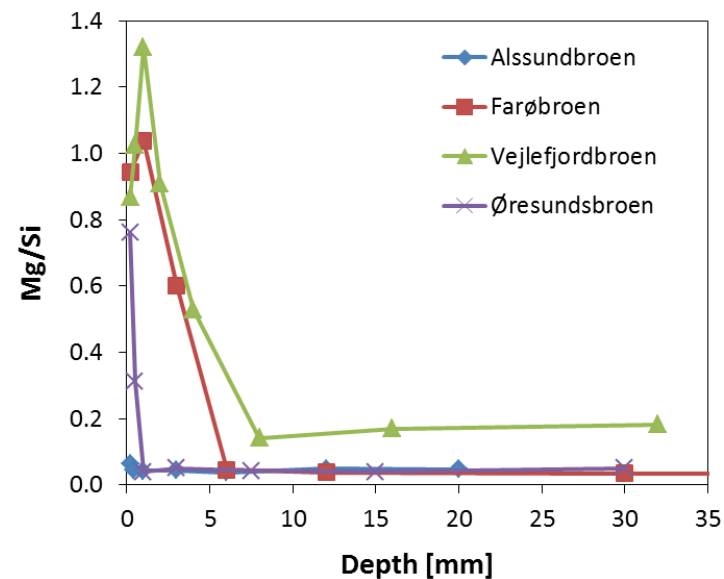
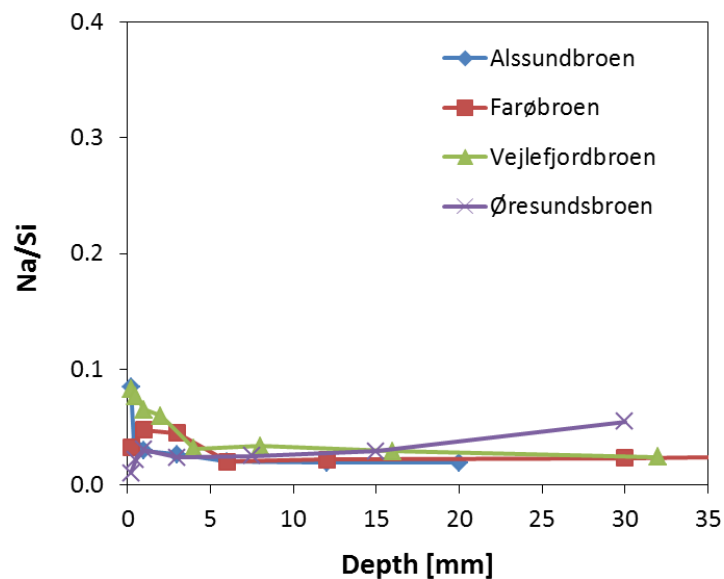
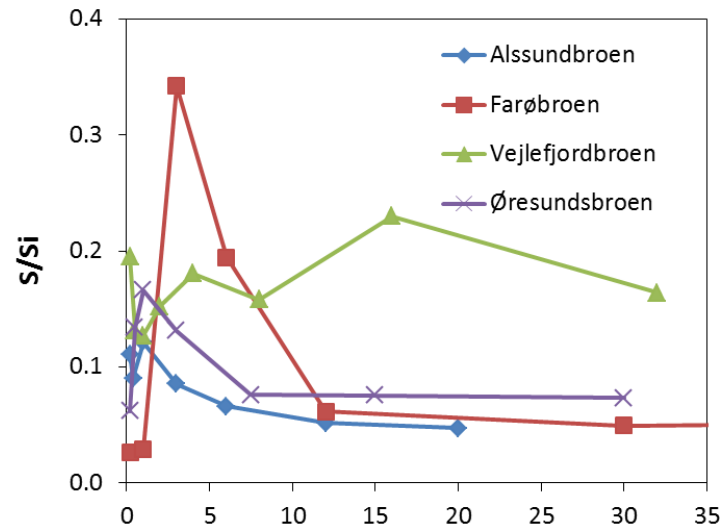
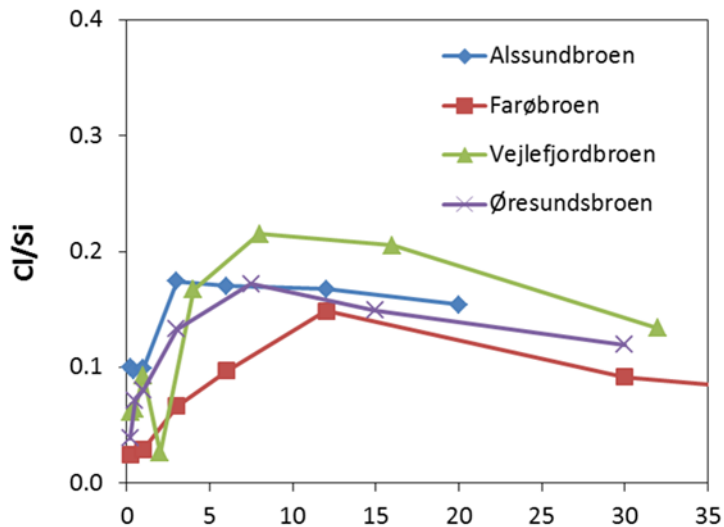
Vejlefjordbroen og Femern K – SEM-EDX



Tidsmæssig variation af S, Mg og Cl



Grundstofprofiler i 4 broer – SEM-EDX



Farøbroen

Pillar, cote -150, south

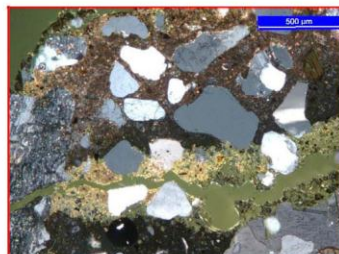
Age: 1980-85



Info
Cement type
Fly ash
Microsilica
Slag
W/C, apparent
Air %

LavAlk
X
-
-
0.40
3-4

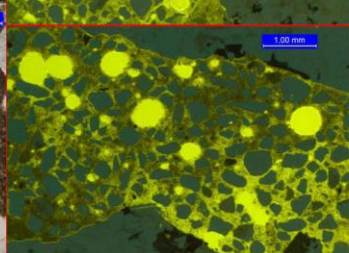
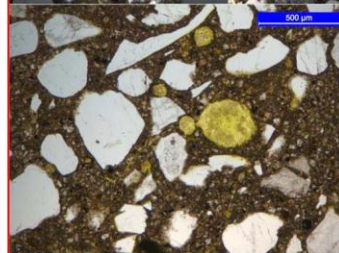
Comments
Core taken in 2012
Cement type: Lavalkali
Section No: 7206-F3



Micro-observations

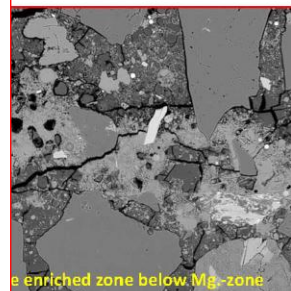
Micro-structural zoning through concrete:

1. Surface is uneven and scaled. A thin calcite crust is occasionally observed, as well as a paste damaged by biological growth.
2. 0-3mm: Partially carbonated paste with bands of black paste. Massive ettringite and thaumasite-like phases are observed in air voids. Paste is highly cracked.
3. 3-10mm: Porous, black paste ettringite and thaumasite-like phases in air voids.
4. Internal paste contains a relatively high amount of CH. Observed in air voids too. Many small autogeneous cracks in paste.

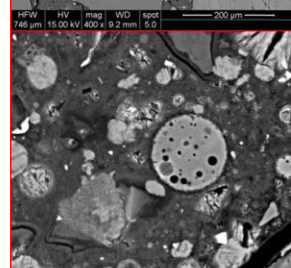


0, south

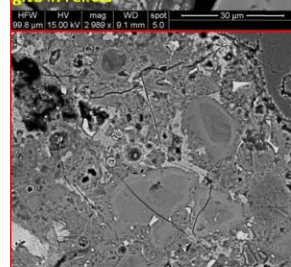
Age: 1980-85



enriched zone below Mg-zone



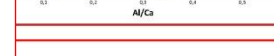
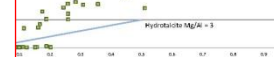
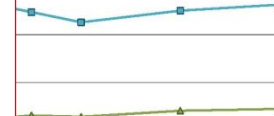
below calcite zone containing gite in refills



or paste, relative high CH content, degree of hydration

0, south

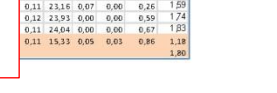
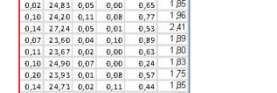
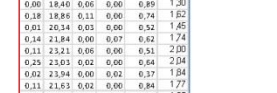
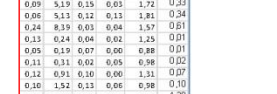
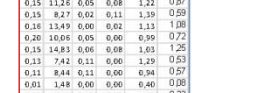
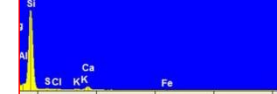
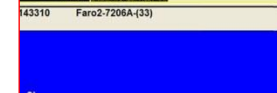
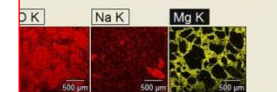
Age: 1980-85



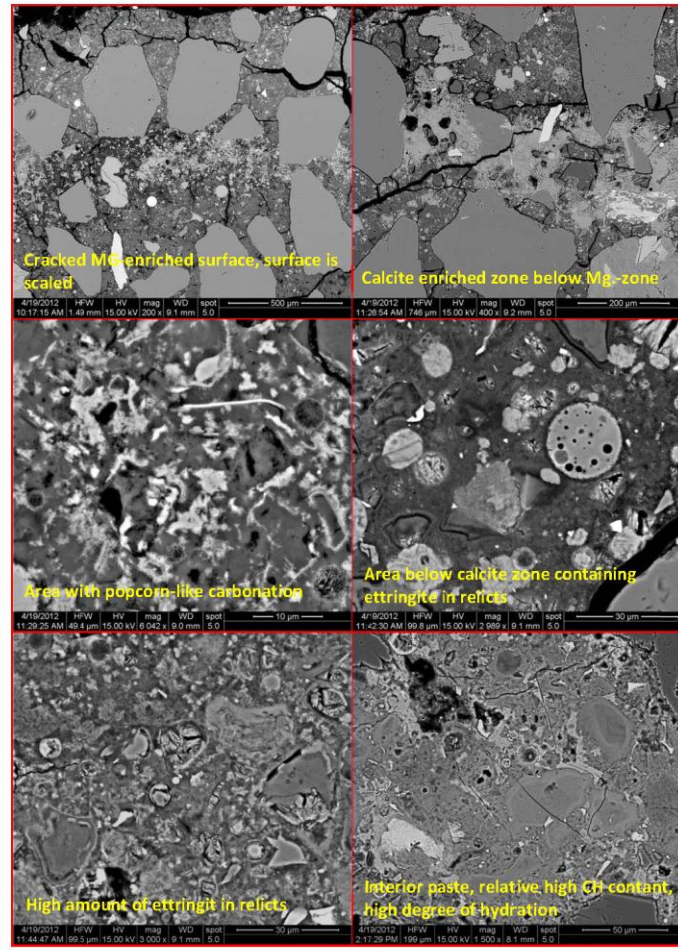
0, south

Age: 1980-85

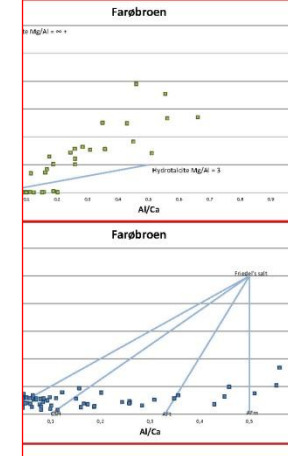
7206A-(33) - Counts (500 Frame(s))



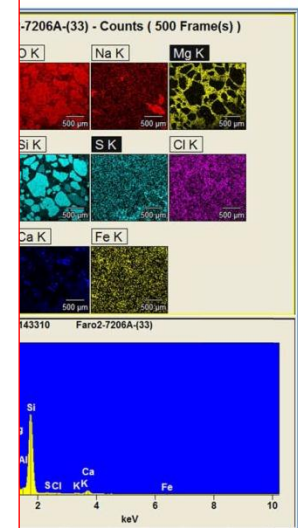
Farøbroen **Pillar, cote -150, south** **Age: 1980-85**



0, south **Age: 1980-85**



0, south **Age: 1980-85**

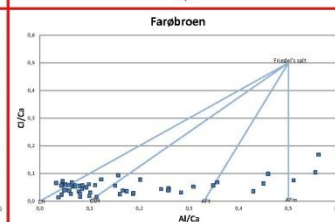
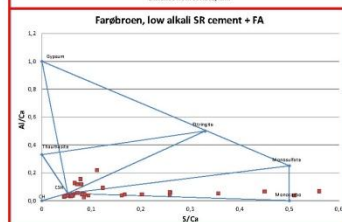
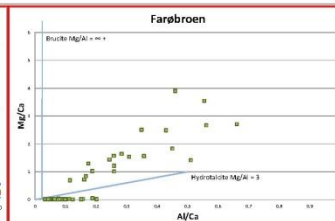
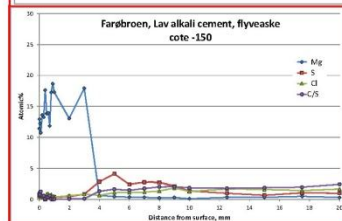
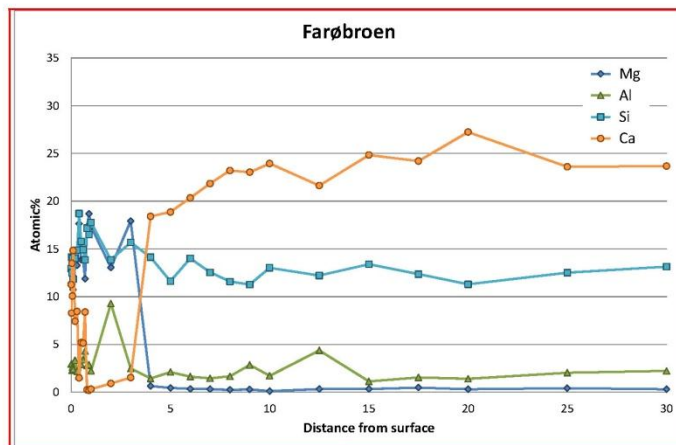


	K	Ca	Ti	Mn	Fe	C/S
0.15	11.26	0.05	0.08	1.22	0.07	
0.15	8.27	0.02	0.11	1.39	0.09	
0.16	13.49	0.00	0.02	1.13	1.08	
0.20	10.06	0.05	0.00	0.99	0.72	
0.15	14.83	0.06	0.08	1.03	1.25	
0.13	7.42	0.11	0.00	1.29	0.53	
0.11	8.44	0.11	0.00	0.94	0.57	
0.01	1.48	0.00	0.00	0.40	0.08	
0.09	5.19	0.15	0.03	1.72	0.33	
0.06	5.13	0.12	0.13	1.81	0.34	
0.24	6.39	0.03	0.04	1.57	0.61	
0.13	0.24	0.04	0.02	1.25	0.01	
0.05	0.19	0.07	0.00	0.88	0.01	
0.11	0.31	0.02	0.05	0.98	0.02	
0.12	0.91	0.10	0.00	1.31	0.07	
0.10	1.52	0.13	0.06	0.98	0.10	
0.00	18.40	0.06	0.00	0.89	1.30	
0.18	18.86	0.11	0.00	0.74	1.82	
0.01	16.34	0.03	0.00	0.52	1.46	
0.14	21.84	0.00	0.07	0.62	1.74	
0.11	23.21	0.06	0.00	0.51	2.00	
0.25	23.03	0.02	0.00	0.64	2.04	
0.02	23.94	0.00	0.02	0.37	1.84	
0.11	21.63	0.02	0.00	0.84	1.77	
0.02	24.83	0.05	0.00	0.65	1.95	
0.10	24.20	0.11	0.08	0.77	1.96	
0.14	17.24	0.05	0.01	0.53	2.41	
0.07	23.60	0.04	0.10	0.89	1.89	
0.11	23.67	0.02	0.00	0.63	1.90	
0.10	14.90	0.07	0.00	0.24	1.83	
0.20	23.93	0.01	0.08	0.57	1.75	
0.14	24.73	0.02	0.11	0.44	1.86	
0.11	23.16	0.07	0.00	0.26	1.59	
0.12	23.93	0.00	0.00	0.55	1.74	
0.11	24.04	0.00	0.00	0.67	1.83	
0.11	15.33	0.05	0.03	0.86	1.18	
					1.80	

Farøbroen

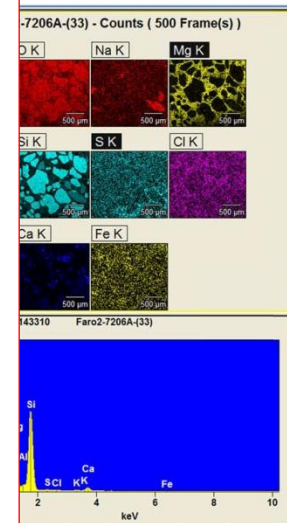
Pillar, cote -150, south

Age: 1980-85



0, south

Age: 1980-85

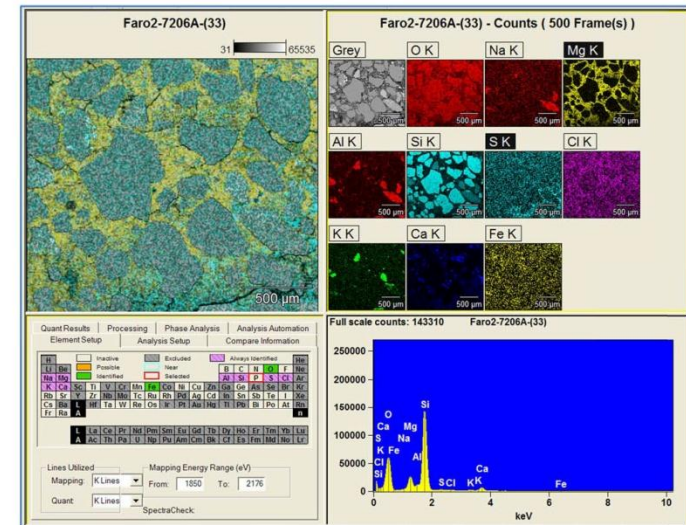


K	Ca	Ti	Mn	Fe	C/S
0.15	11.26	0.05	0.08	1.22	0.07
0.15	8.27	0.02	0.11	1.39	0.09
0.16	13.49	0.00	0.02	1.13	1.08
0.20	10.04	0.05	0.00	0.99	0.72
0.15	14.83	0.06	0.08	1.03	1.25
0.13	7.42	0.11	0.00	1.29	0.53
0.11	8.44	0.11	0.00	0.94	0.57
0.01	1.48	0.00	0.00	0.40	0.08
0.09	5.13	0.15	0.03	1.72	0.33
0.06	5.13	0.12	0.13	1.81	0.34
0.24	8.39	0.03	0.04	1.57	0.61
0.13	0.24	0.04	0.02	1.25	0.01
0.05	0.19	0.07	0.00	0.88	0.01
0.11	0.31	0.02	0.05	0.98	0.02
0.12	0.91	0.10	0.00	1.31	0.07
0.10	1.52	0.13	0.06	0.98	0.10
0.00	18.40	0.06	0.00	0.89	1.30
0.18	18.96	0.11	0.00	0.74	1.82
0.01	16.34	0.03	0.00	0.52	1.46
0.14	21.84	0.00	0.07	0.62	1.74
0.11	23.21	0.06	0.00	0.51	2.00
0.25	23.03	0.02	0.00	0.64	2.04
0.02	23.94	0.00	0.02	0.37	1.84
0.11	21.63	0.02	0.00	0.84	1.77
0.02	24.83	0.05	0.00	0.65	1.86
0.10	24.20	0.11	0.08	0.77	1.86
0.14	27.24	0.05	0.01	0.53	2.41
0.07	23.60	0.04	0.10	0.89	1.89
0.11	23.67	0.02	0.00	0.63	1.80
0.10	24.90	0.07	0.00	0.24	1.83
0.20	23.93	0.01	0.08	0.57	1.75
0.14	24.73	0.02	0.11	0.44	1.86
0.11	23.16	0.07	0.00	0.26	1.59
0.12	23.93	0.00	0.00	0.59	1.74
0.11	24.04	0.00	0.00	0.67	1.83
0.11	15.33	0.05	0.03	0.86	1.18
					1.80

Farøbroen

Pillar, cote -150, south

Age: 1980-85



Phase distribution through the surface region of the concrete.

Fanbeam - #A	Dist	Phase	Na	Mg	Al	Si	S	Cl	Ca	Ti	Mn	Fe	CS
Fanbeam-206A	0	CH	0.76	11.42	2.92	12.93	0.24	0.55	0.48	0.53	11.26	0.05	0.88
Fanbeam-206A-0	0.02	CH	0.61	12.93	2.95	14.12	0.21	0.43	0.56	0.57	8.27	0.62	0.11
Fanbeam-206A-1	0.04	CH	0.33	12.93	2.95	14.12	0.21	0.43	0.56	0.57	8.27	0.62	0.11
Fanbeam-206A-2	0.06	CH	0.07	12.24	2.60	14.01	0.11	0.44	0.57	0.20	10.06	0.05	0.99
Fanbeam-206A-3	0.08	CH	0.07	12.24	2.60	14.01	0.11	0.44	0.57	0.20	10.06	0.05	0.99
Fanbeam-206A-4	0.1	CH	0.81	10.74	2.39	11.83	0.12	0.56	0.37	0.15	14.83	0.06	1.08
Fanbeam-206A-5	0.2	CH	0.67	13.61	3.34	14.00	0.14	0.59	0.47	0.73	7.41	0.03	1.29
Fanbeam-206A-6	0.3	CH	0.67	13.61	3.34	14.00	0.14	0.59	0.47	0.73	7.41	0.03	1.29
Fanbeam-206A-7	0.4	CH	0.67	13.61	3.34	14.00	0.14	0.59	0.47	0.73	7.41	0.03	1.29
Fanbeam-206A-8	0.4	CH	0.00	17.63	1.66	10.70	0.00	0.00	0.28	0.61	1.88	0.00	0.40
Fanbeam-206A-9	0.5	CH	0.00	13.85	2.91	15.79	0.00	0.35	0.87	0.59	5.19	0.05	1.72
Fanbeam-206A-10	0.6	CH	0.42	13.91	2.59	14.94	0.00	0.46	0.90	0.05	6.12	0.13	1.81
Fanbeam-206A-11	0.7	CH	0.49	13.85	4.28	13.13	0.00	0.53	0.24	0.83	0.94	0.13	1.61
Fanbeam-206A-12	0.8	CH	0.51	17.29	2.79	17.17	0.03	0.35	0.75	0.13	0.24	0.04	1.25
Fanbeam-206A-13	0.9	CH	0.62	18.66	2.86	14.64	0.04	0.45	0.05	0.05	6.07	0.00	1.88
Fanbeam-206A-14	0.9	CH	0.21	17.29	2.79	17.17	0.03	0.35	0.75	0.13	0.24	0.04	1.25
Fanbeam-206A-15	2	CH	0.41	13.65	2.98	13.86	0.13	0.43	0.58	0.12	0.91	0.10	1.31
Fanbeam-206A-16	3	CH	0.31	17.93	2.47	15.68	0.05	0.83	0.53	0.10	1.52	0.03	0.98
Fanbeam-206A-17	4	CH	0.98	0.63	1.43	14.13	0.05	2.83	0.4	0.00	18.40	0.06	0.89
Fanbeam-206A-18	5	CH	0.51	14.44	2.54	11.67	0.00	0.68	0.18	0.00	0.00	0.00	0.82
Fanbeam-206A-19	6	CH	0.26	0.34	1.62	14.60	0.00	2.40	1.11	0.03	20.34	0.03	0.52
Fanbeam-206A-20	7	CH	0.25	0.32	1.44	12.54	0.00	2.76	1.15	0.14	21.84	0.00	0.67
Fanbeam-206A-21	8	CH	0.24	0.23	1.59	12.54	0.00	2.76	1.15	0.14	21.84	0.00	0.67
Fanbeam-206A-22	9	CH	0.12	0.28	2.84	11.27	0.00	1.11	1.82	0.25	23.03	0.02	0.64
Fanbeam-206A-23	10	CH	0.22	0.10	1.71	10.32	0.18	1.34	1.26	0.02	23.94	0.00	0.62
Fanbeam-206A-24	12.5	CH	0.36	0.32	1.47	12.21	0.00	0.97	1.48	0.51	21.63	0.02	0.84
Fanbeam-206A-25	17.5	CH	0.29	0.32	1.59	12.21	0.00	0.68	0.02	0.02	23.94	0.00	0.62
Fanbeam-206A-26	17.5	CH	0.28	0.47	1.53	12.36	0.14	1.04	1.41	0.10	24.20	0.11	0.88
Fanbeam-206A-27	20	CH	0.18	0.30	1.40	13.29	0.00	0.98	1.45	0.14	27.24	0.05	0.53
Fanbeam-206A-28	25	CH	0.58	0.41	2.63	12.51	0.12	1.10	1.34	0.07	23.60	0.04	0.10
Fanbeam-206A-29	28	CH	0.38	0.30	1.44	11.11	0.00	0.68	0.01	0.01	23.94	0.00	0.62
Fanbeam-206A-30	33	CH	0.26	0.32	1.34	13.59	0.02	0.75	1.47	0.10	24.90	0.07	0.24
Fanbeam-206A-31	60	CH	0.23	0.52	1.38	13.66	0.00	0.75	1.37	0.20	23.93	0.01	0.68
Fanbeam-206A-32	60	CH	0.23	0.17	1.69	13.66	0.00	0.75	1.37	0.20	23.93	0.01	0.68
Fanbeam-206A-33	80	CH	0.58	0.04	1.66	14.57	0.00	0.53	0.99	0.11	23.16	0.07	0.26
Fanbeam-206A-34	80	CH	0.58	0.04	1.66	14.57	0.00	0.53	0.99	0.11	23.16	0.07	0.26
Fanbeam-206A-35	80	CH	0.25	0.35	1.42	13.73	0.14	0.81	0.89	0.12	23.93	0.00	0.59
Fanbeam-206A-36	93	CH	0.00	0.24	1.95	13.11	0.00	1.11	0.66	0.11	24.04	0.00	0.67
Average			0.42	1.66	2.44	13.92	0.08	1.02	0.91	1.11	15.33	0.05	0.86
Average under Mg zone													1.38