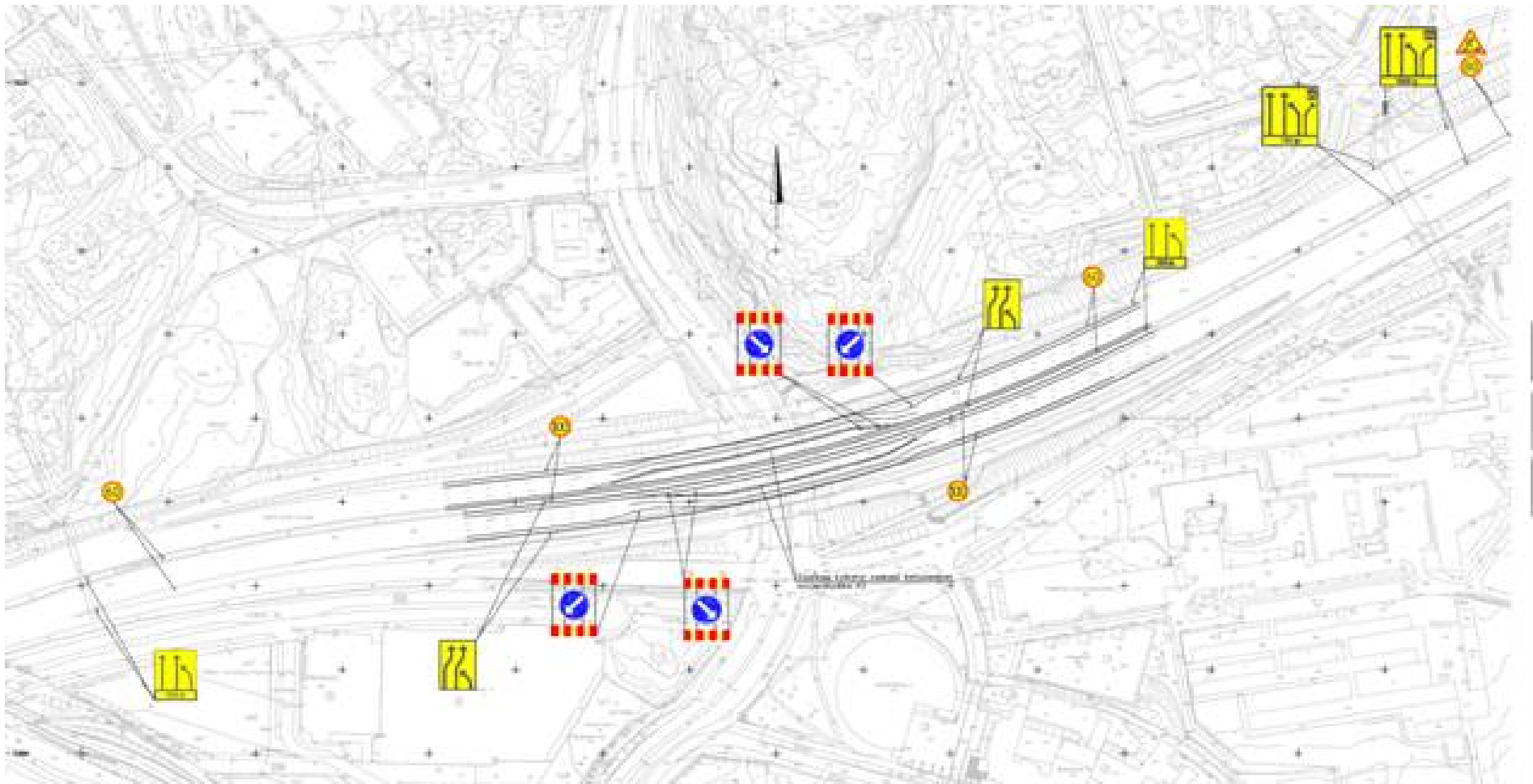


Accelerated renovation of Bridge Surface Decks in Finland

1. Construction of traffic steering systems
2. Removal of existing bridge pavement and water proofing
3. Drilling of bridge deck drain pipes
4. Chiselling and rinsing
5. Casting leveling concrete
6. Shot-blast cleaning of water proofing substrate
7. Waterproofing works, epoxy compacting and laying of sheet membranes or shot spreading of water proofing



Construction of traffic steering systems



pvm

DM xxxxxx Laatija

1

Removal of existing bridge pavement and water proofing



pvm

DM xxxxxx Laatija

2

Drilling of bridge deck drain pipes



pvm

DM xxxxxx Laatija

3

Chiselling and rinsing



pvm

DM xxxxxx Laatija

4

DESTIA

Chiselling and rinsing



pvm

DM xxxxxx Laatija

5

Casting leveling concrete



pvm

6

DESTIA

Repair by 2 m lines, Professors Road Bridge 2010



pvm

DM xxxxxx Laatija

7

Shot-blast cleaning



pvm

DM xxxxxx Laatija

8

Waterproofing works, epoxy compacting and sheet membranes



pvm

DM xxxxxx Laatija

9

Epoxy compacting



pvm

DM xxxxxx Laatija

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DESTIA

Waterproofing works, shot spread water proofing



pvm

11

Holyday detector test



pvm

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12

Shelters

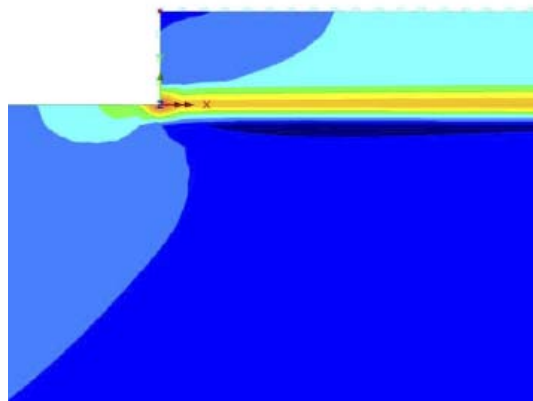
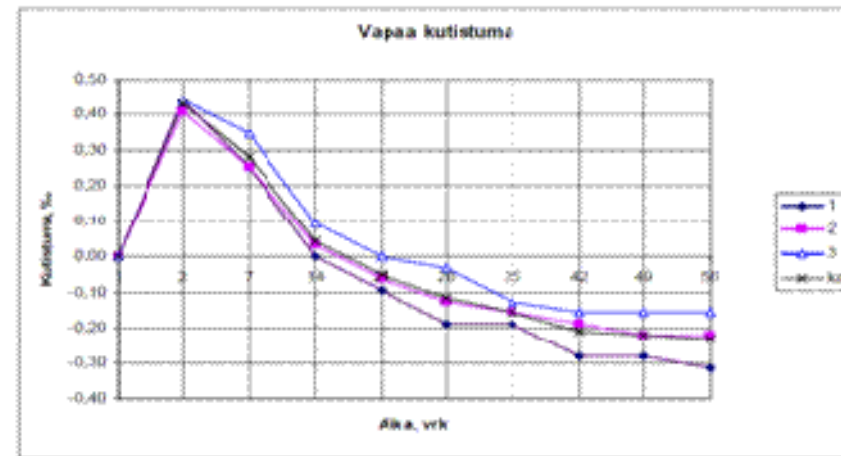


pvm

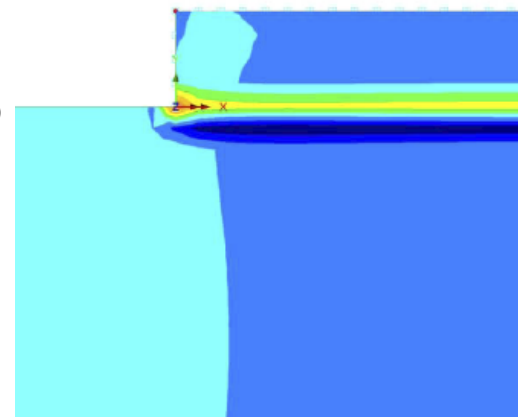
DM xxxxxx Laatija

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Stresses due to different shrinkage



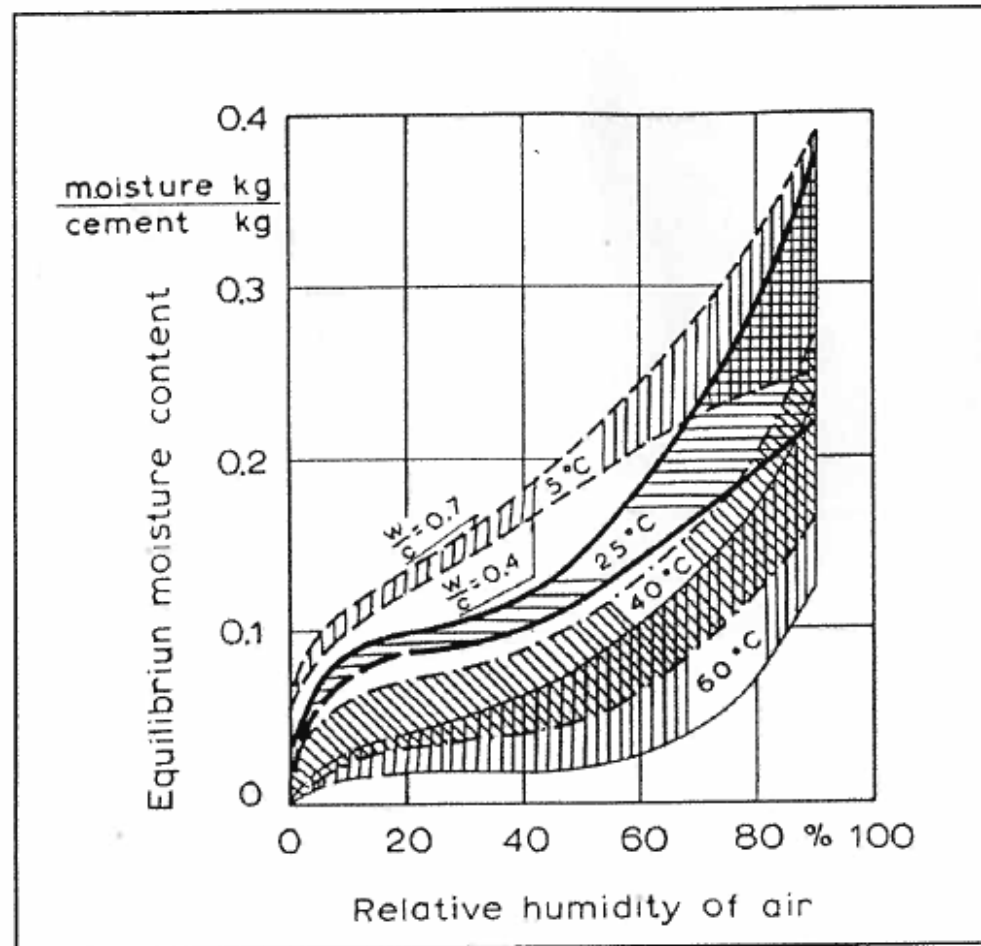
2,2 N/mm²
 7,7 N/mm² (halkeilun jälkeen ~ 0)
 0,7 N/mm²



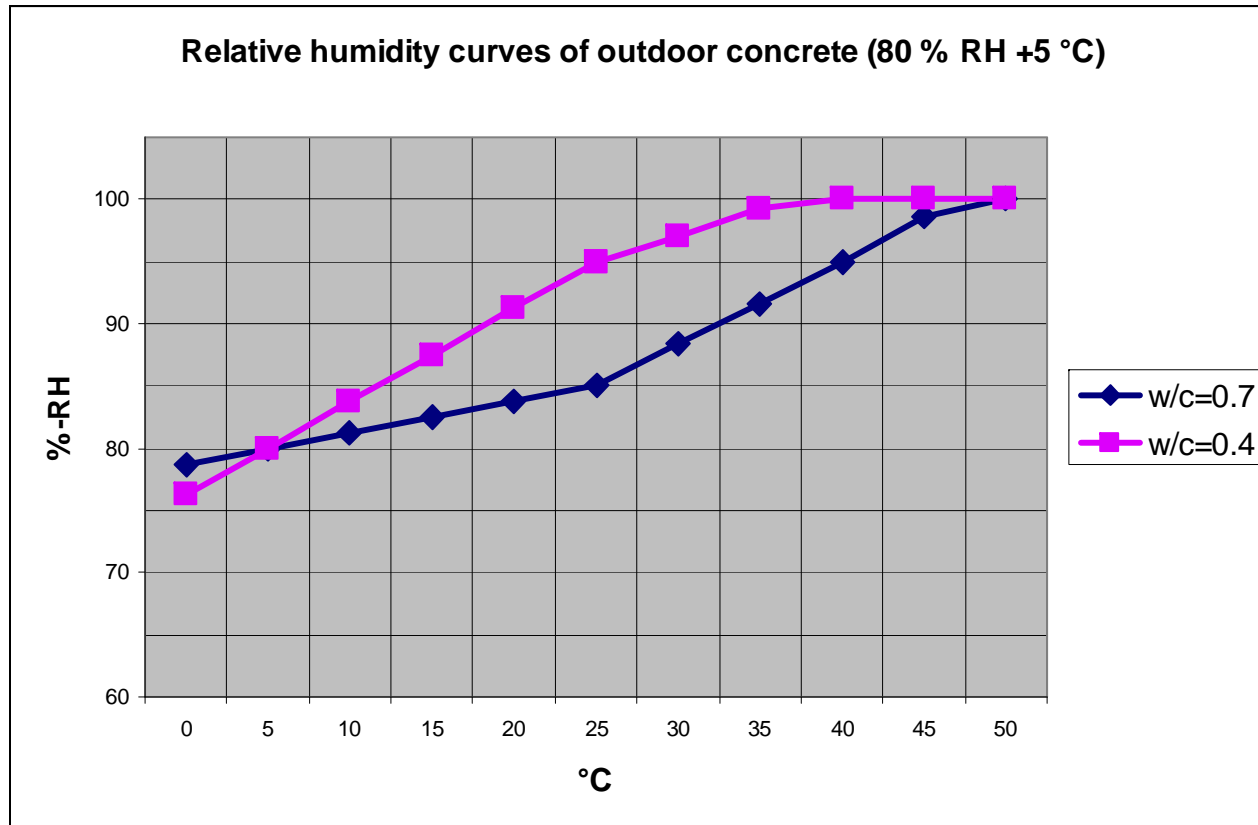
0 N/mm²
 3,7 N/mm² (halkeilun jälkeen ~ 0)
 0 N/mm²

The moisture content – relative humidity equilibrium curve for concrete

Professor Sven Pihlajavaara 1974



Drying and curing

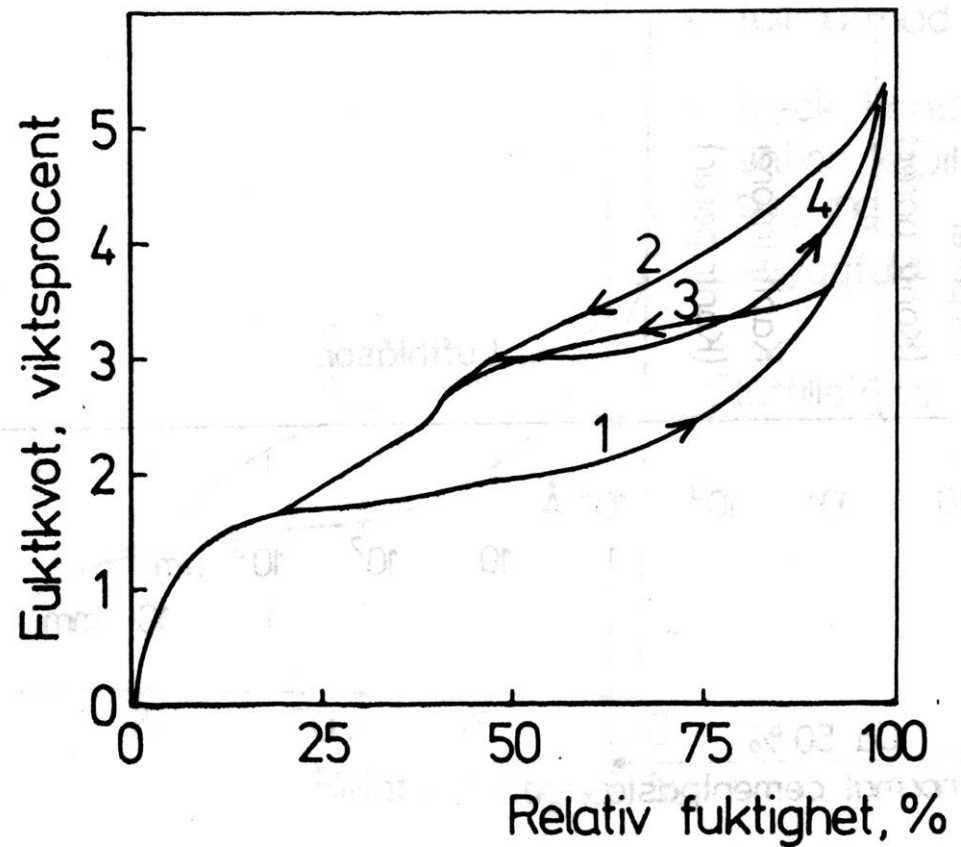


The moisture content – relative humidity equilibrium during absorption and desorption, Lennart Ahlgren, Sven G Bergström, Göran Fagerlund, Lars-Olof Nilsson, CBI kursverksamheten, Stockholm 1976

1 and 4 concrete absorbs water

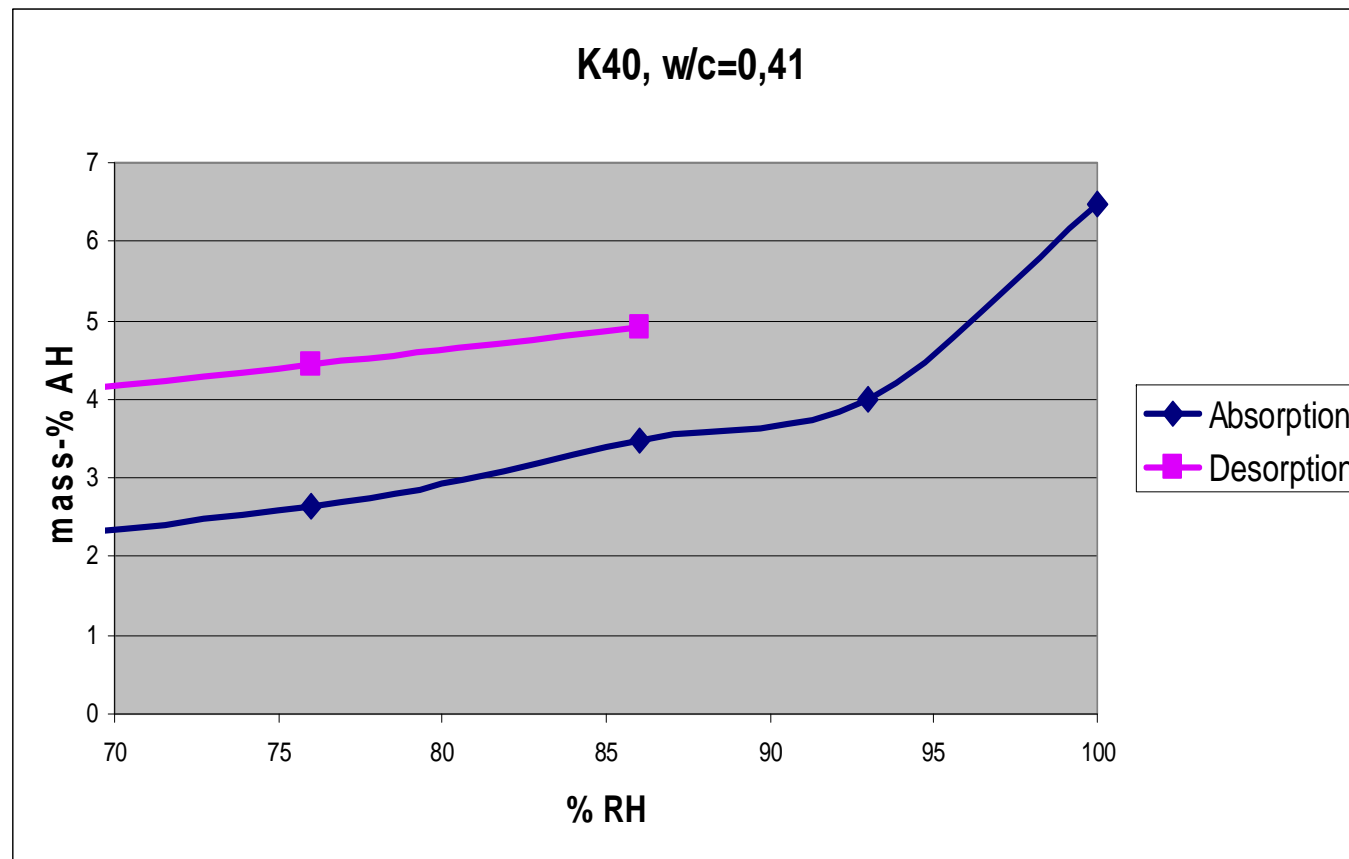
2 and 3 concrete is drying desorption

The drying curve is always above the absorption curve, hysteresis

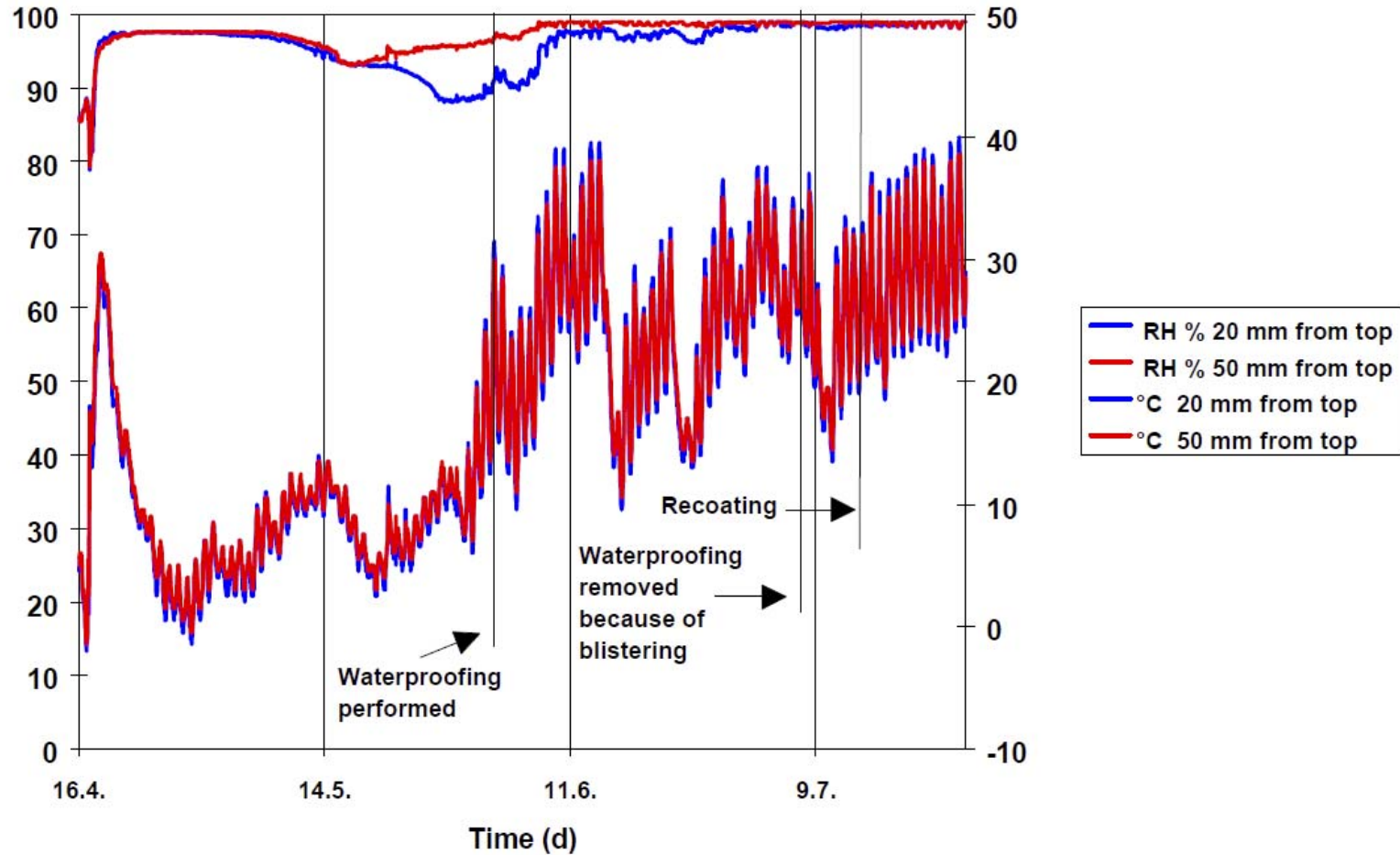


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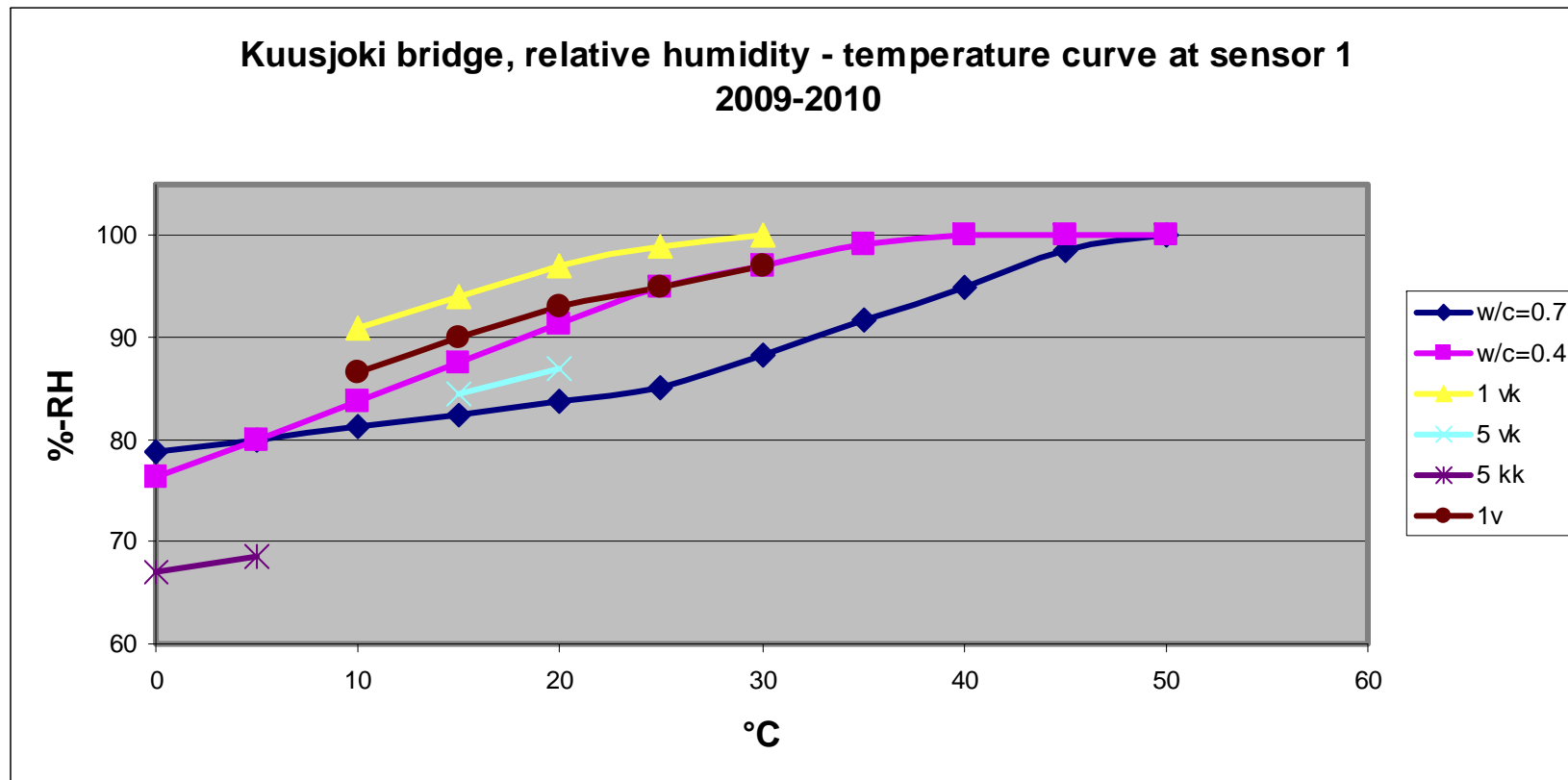
Absorption / desorption equilibrium curves



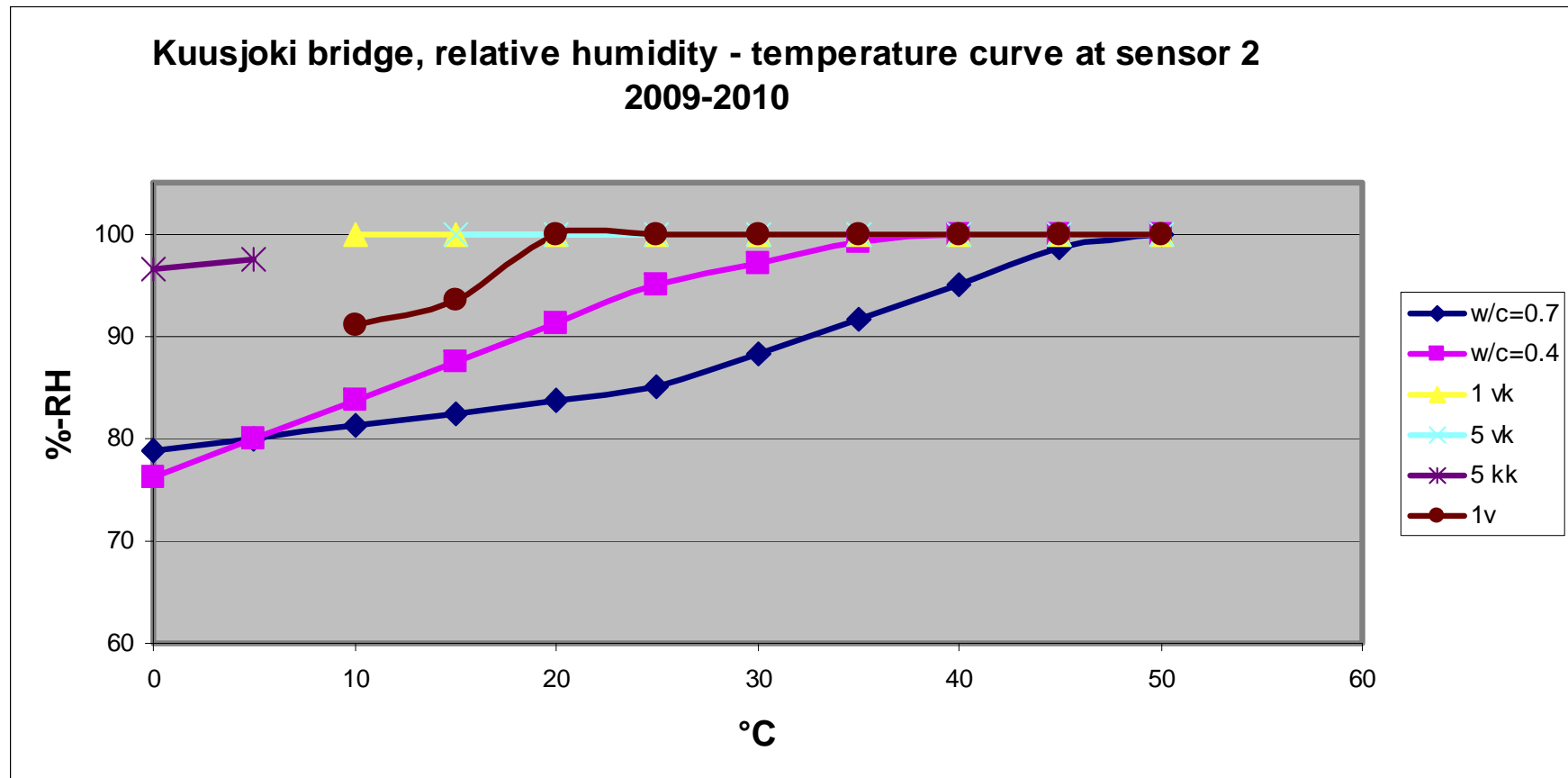
Drying of substrate in new bridges



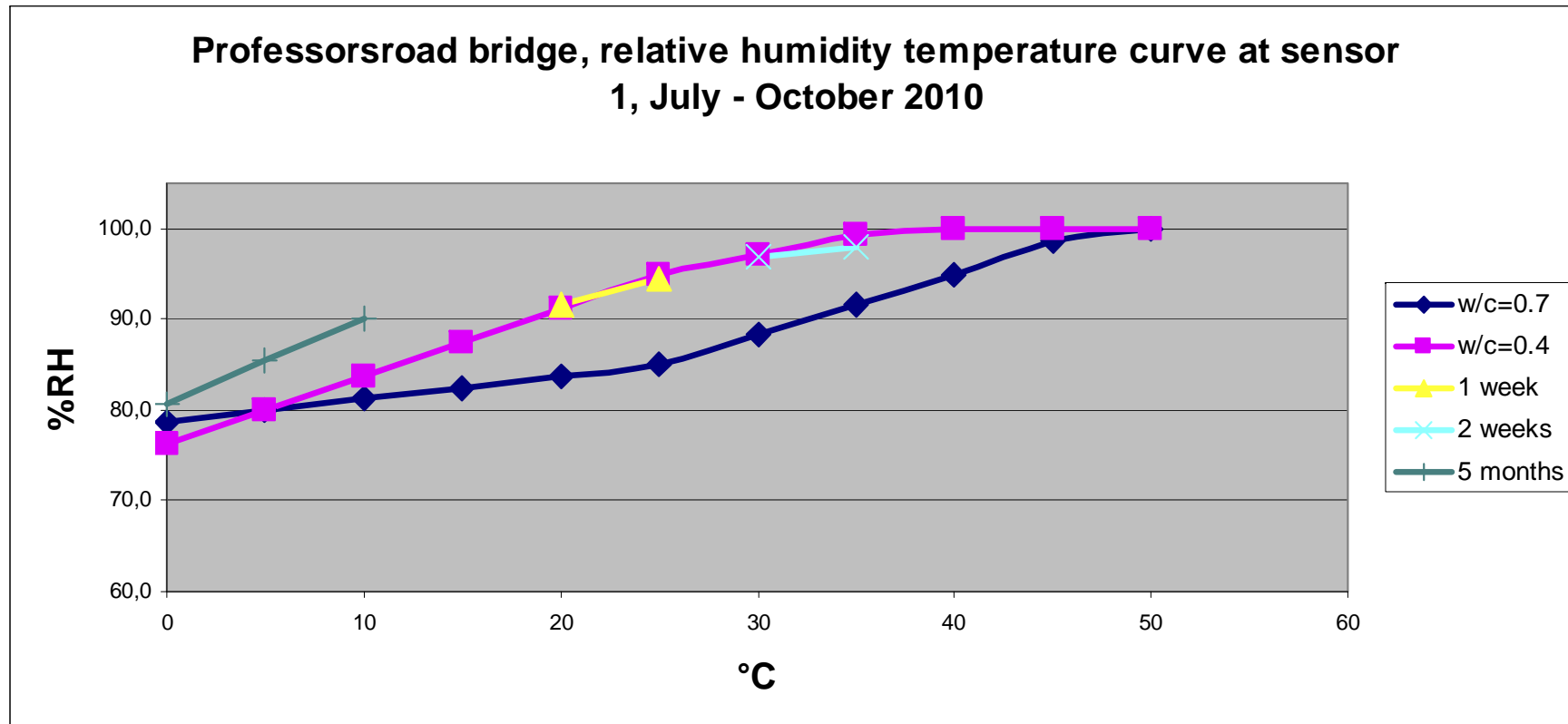
Drying of leveling concrete at refurbishment Bridge 1, Kuusjoki



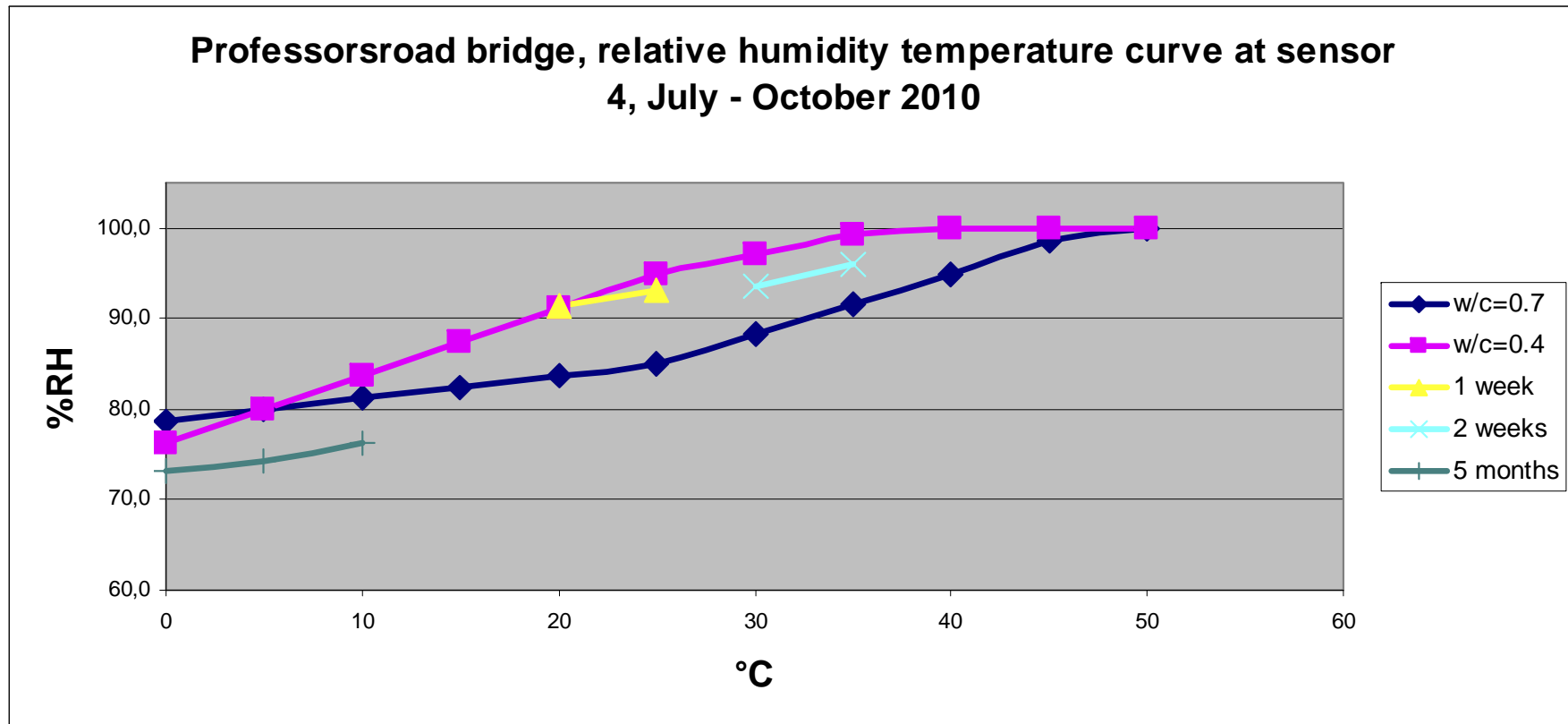
Drying of leveling concrete at refurbishment Bridge 1, Kuusjoki



Drying of leveling concrete at refurbishment Bridge 2, Professors Road Bridge

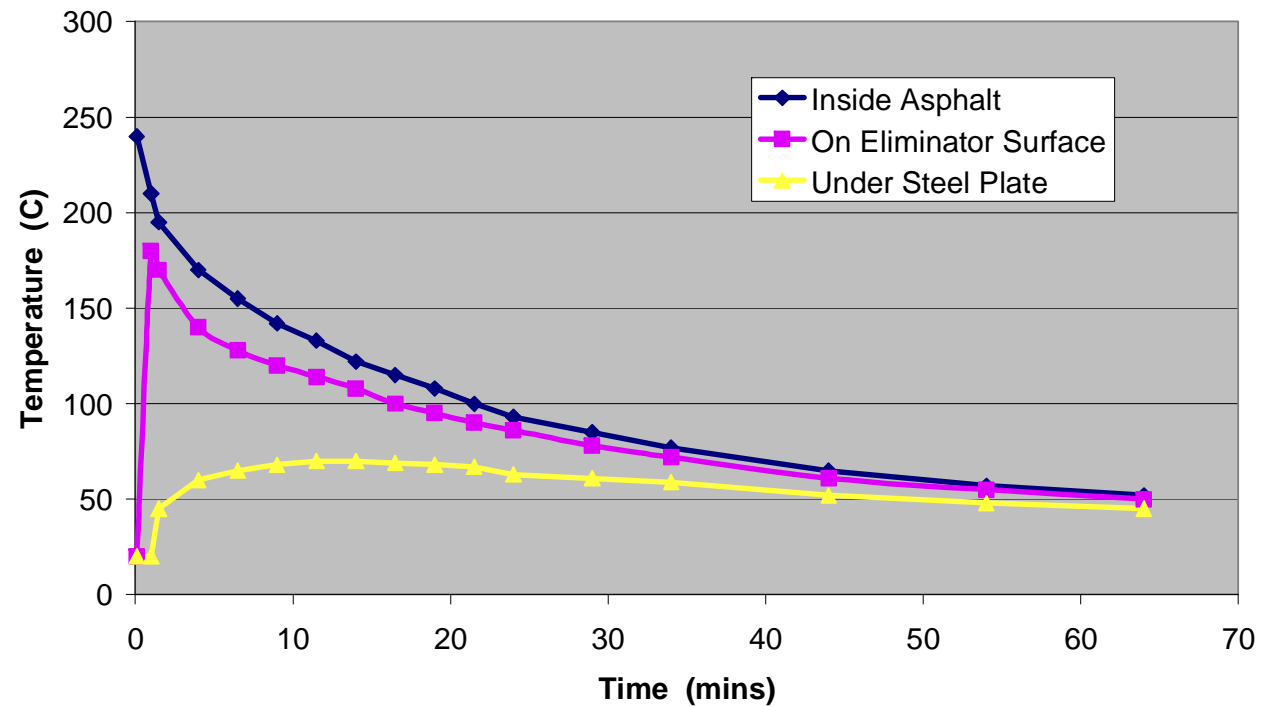


Drying of leveling concrete at refurbishment Bridge 2, Professors Road Bridge

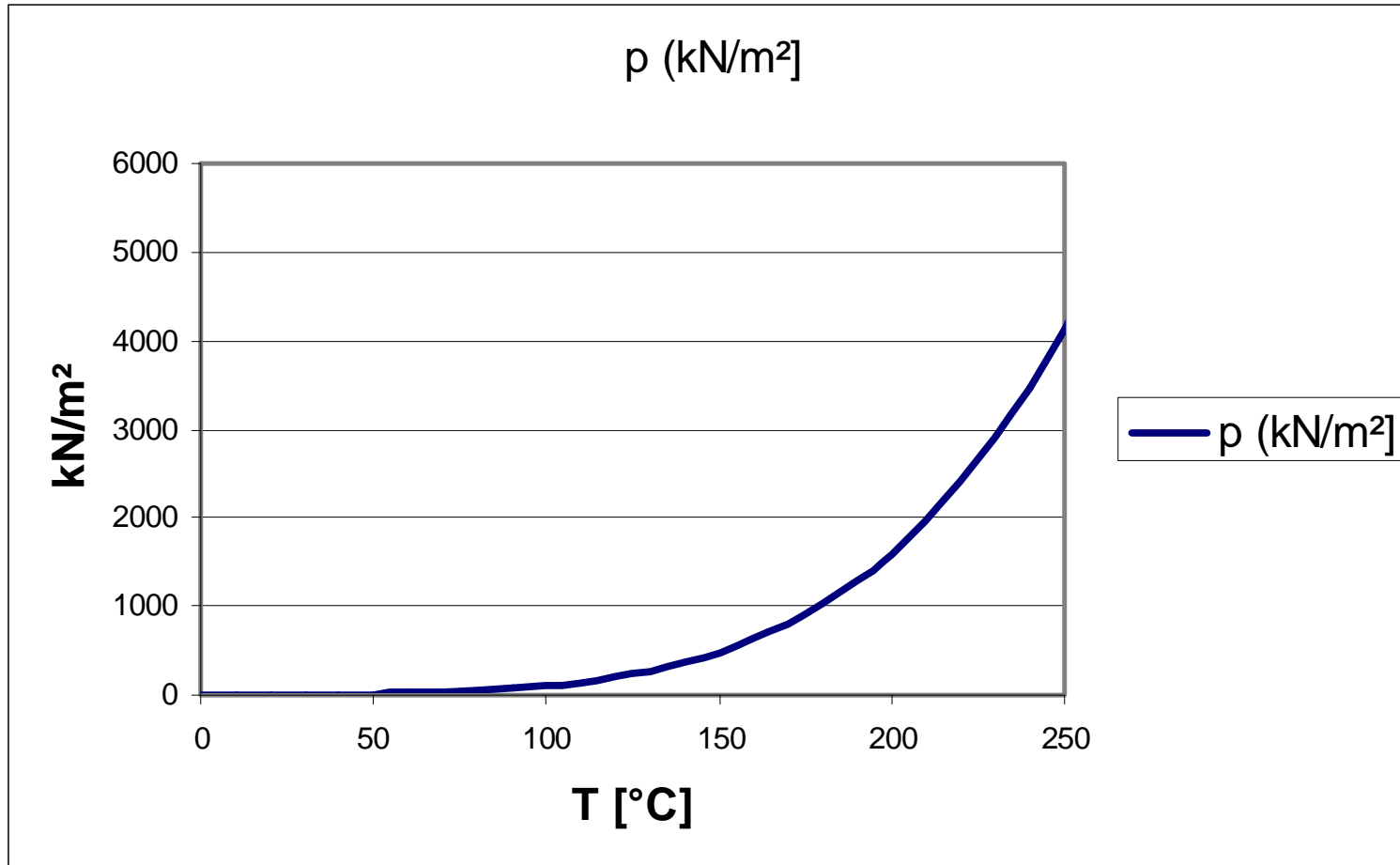


Heat transfer through waterproofing, Stirling Lloyd Ltd laboratory results

Heat Profile on Eliminator on Asphalt application



Vapour pressure



Working time

Scope of works and traffic hindrance time

Bridge	Kuusjoki	Suonenjoki		Pihlajanmäki		Luoma			Professors Road	
Year	2009	2009	2009	2010	2010	2010	2010	2010	2010	2010
Deck-m ²	110	135		1330		700			440	
Phase	1	1	2	1	2	1	2	3	1	2
Levelling Concrete	SRL-FIN	SRL-FIN	SRL-FIN	SRL-FIN	SRL-FIN	SRL-FIN	SRL-FIN	SRL-FIN	RAPI-tec®	RAPI-tec®
Waterproofing	Eliminator	Epoxy/memb	Epoxy/memb	Epoxy/memb	Epoxy/memb	Epoxy/memb	Epoxy/memb	Epoxy/memb	Eliminator	Eliminator
Total time	10 days	14 days	13 days	14 days	17 days	13 days	12 days	9 days	7 days	7 days

Time needed for basic work steps

Bridge	Kuusjoki	Suonenjoki		Pihlajanmäki		Luoma			Professors Road	
Traffic steering	2 h	2 h	3 h	1 days	1 days	1 days	0.5 days	0.5 days	3 h	3 h
Removal of asphalt, etc.	3 h	5 h	4 h	2 days	1 days	1 days	0.5 days	1 days	1 days	1 days
Shelter	11 h	4 h	5 h	2 days	2 days	2 days	1 days	-	4 nights	
Draining and water jetting	2 days	17 h	17 h	3 days	2 days	2 days	2 days	2 days	1.5 days	1 days
Levelling concrete	12 h	9 h	9 h	2 days	2 days	3 days	2 days	2 days	1.5 days	1 days
Curing	3 days	4 days	4 days	2.5 days	2.5 days	2 days	2 days	3 days	1 days	1 days
Shot-blasting, primer	9 h	2 h	2 h	1 days	1 days	1 days	1 days	1 days	1 days	1 days
Water proofing	8 h	4 days	4 days	4 days	4 days	2 days	2 days	2 days	1 days	1 days
Shelter dismantling	14 h	14 h	10 h	1 days	1 days	1 days	1 days	-	-	
Pavement works	6 h	6 h	8 h	1 days	2 days	1 days	1 days	1 days	1 days	1 days

Working time, estimation

- 1 Traffic arrangement, removal of existing pavement
- 1-2 Water jetting
- 3 Drain pipes, preparation for leveling concrete
- 4-5 Curing
- 6 Sandblasting, water proofing works
- 7 Water proofing works continuing
- 8 Pavement and opening for traffic

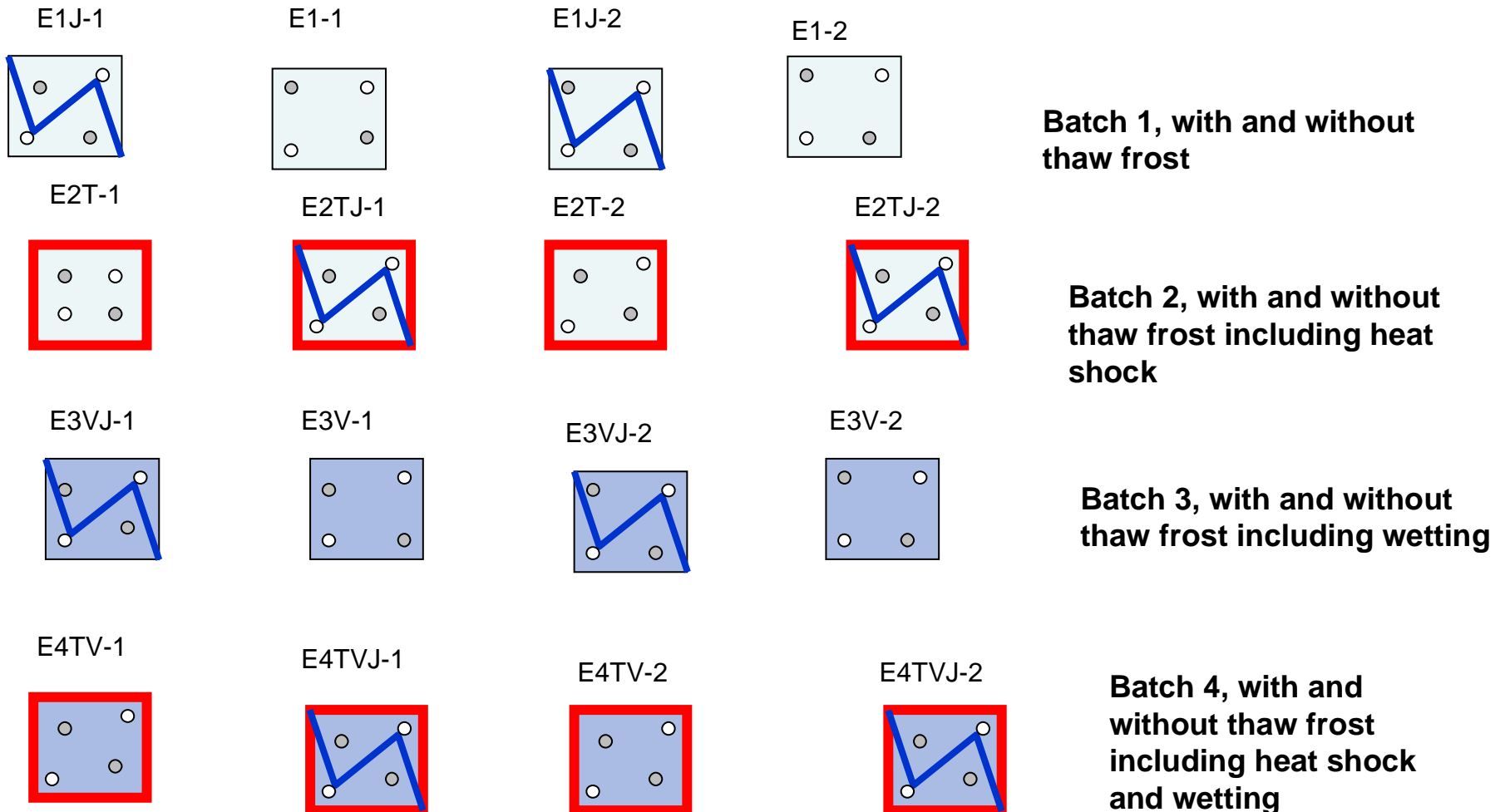
Quality Control 2009

	Kuusjoen Bridge	Suonenjoki	Unit
Substr. pull off	1.91-4.58	0.15	N/m ²
Substr. Moisture		4.5-7.4	m-% AH
Concrete Cube Strength	57.5-66.5		N/mm ²
Concrete Pull off Strength	3.11-4.42	0.8	N/mm ²
Concrete Tramex m-% AH	4.2-4.8		m-% AH
Concrete Laboratory m-% AH	3.6	4.5-5.0	m-% AH
% RH > 4 months +5 °C	80.5-97.5		% RH
Eliminator pull off	2.26-5.62		N/mm ²
Epoxy pull off		ok !	N/mm ²
Membrane pull off		111-134 %	% of required

Quality Control 2010

	Pihlajanmäki	Luoma	Professors road	Unit
Substr. pull off	1.03-2.96	1.52-2.42	0.42-2.85	N/mm ²
Substr. Moisture				m-% AH
Concrete Cube Strength	49.5-75.0			N/mm ²
Concrete Pull off Strength	1.04-1.61	1.6-2.6	1.2-2.0	N/mm ²
Shrinkage	<0.04/28 vrk			
Concrete Tramex m-% AH		3.9-5.0		m-% AH
Concrete Laboratory m-% AH	4.2-5.6		8.8-9.4	m-% AH
% RH > 4 months +5 °C	78-89		74-90	% RH
Eliminator pull off			1.04-2.67	N/mm ²
Epoxy pull off	1.04-2.92	3		N/mm ²
Membrane pull off	97-141 %	103-200 %		% of required

Laboratory 8 months pull off test



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Conclusion

1. A refurbishment of bridge decks costs, 250-300 €/m².
2. The extra costs for rapid renewal of pavement and water proofing including concrete deck repair costs 40-100 €/m² or even more in case special concretes are used.
3. The main contractor shall be in charge of supervision. The consequences of failures shall be born by him, a transfer responsibilities to subcontractors shall not be allowed.
4. Laying of leveling concrete shall be implemented by certificated subcontractors in a similar way as water proofing works are certificated to certain products and contractors.
5. No destructive testing is needed for the verification of bond between the old and new concrete and the water proofing and concrete