

**Freeze-thaw cycling with de-icing salt immersion, EN 13687-1
PAGEL V1/160 (0-16 mm)**

Requested by: Alimex Oy

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Assignment **Freeze-thaw cycling with de-icing salt immersion, EN 13687-1
PAGEL V1/160 (0-16 mm)**

Samples Concrete test specimens of dimensions 300 x 300 x 100 mm MC(0,40) according to EN 1766 were prepared by VTT Expert Services Ltd on the week 5, 2016. Concrete slabs were cured emerged in water bath for 27 days. Surfaces of the concrete slabs were grit-blasted.

Repair grout PAGEL V1/160 was cast onto the concrete slabs by the customer on 14.3.2016 at VTT Expert Services Ltd, at conditions of temperature $(20 \pm 2)^{\circ}\text{C}$ and relative humidity RH $(60 \pm 5) \%$. Thickness of a repair grout layer on the concrete was approximately 50 mm.

After the application of the repair product the test pieces were cured for regime of 6 days under water followed by 21 days curing at temperature of $(20 \pm 2)^{\circ}\text{C}$ and relative humidity RH $(60 \pm 5) \%$.

Samples were edge sealed (all sides and rear of the concrete test specimen) up to 5 mm on to the face of the sample with water proofing.

Performance of the test Freeze-thaw cycling with De-icing salt immersion, EN 13687-1

After completing the preparation of the test specimens, two of the test specimens were immersed in water for 24 h. After this period the test pieces were cycled 50 times. One cycle consisted of:

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- immersion to the tank containing saturated sodium chloride solution at a temperature of $(-15 \pm 2)^{\circ}\text{C}$ for 2 h + storage in water tank at temperature of $(21 \pm 2)^{\circ}\text{C}$ for 2 hours

Test was performed on 13.5.- 6.6.2016. Meanwhile one reference test specimen (not exposed) was stored at temperature of $(20 \pm 2)^{\circ}\text{C}$ and relative humidity RH $(60 \pm 5) \%$. Temperature of water and saturated sodium chloride solution was measured and monitored with calibrated FLUKE 52II Thermometer, TL14846, July 2016.

After the cycling the exposed test specimens were conditioned at temperature of $(20 \pm 2)^{\circ}\text{C}$ and relative humidity RH $(60 \pm 5) \%$ at least for seven days.

Pull-off strength, EN 1542

Surfaces of the test specimen were cleaned up with steel brush for any loose material. Five cores, \varnothing 50 mm were drilled to the surface up to a depth of (15 ± 5) mm into the concrete substrate, photo in the Appendix 5.

Dollies (\varnothing 50 mm) were glued with 2-pack Epoxy adhesive on the cores for pull-off test, which was performed with calibrated F15D Easy M 2000, TL 13166, 20.6.2016 pull-off adhesion tester. Loading rate in the test was 100 N/ s. Pull-off tests were performed 21.6-27.6.2016.

Results

Freeze-thaw cycling with De-icing salt immersion, EN 13687-1

No cracks were observed during or after the Freeze-thaw cycling with De-icing salt immersion tests. Some easily removable cement glue was observed on surfaces on the test specimens after the expose tests.

Pull-off strength, EN 1542

As the debonding took place mainly in concrete the results represents the strength of the concrete slabs in the test.

Results show that the bond strength (adhesion) / pull-off strength of the repair grout was higher than the strength of the concrete slabs.

Test results, tensile bond strength and type of failure, are presented in the table 1.

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Table 1. The pull-off strength, MPa of Repair grout PAGEL V1/160. Reference values and results after the Freeze-thaw cycling with De-icing salt immersion, EN 13687-1 for 50 cycles. Manufacturer: PAGEL SPEZIAL-BETON GMBH & CO.KG, Germany, Importer: Alimex Oy.

Sample/ test specimen no.	Cylinder no.	Type of failure	Stress at break		
			Mpa	Mean value MPa	S.D. MPa
Unexposed / 1 (reference)	1	50% cohesion in concrete, 50% cohesion in grout	2.3	2.4	0.3
	2	100% cohesion in concrete	2.7		
	3	100% cohesion in concrete	2.5		
	4	100% cohesion in grout	1.9		
	5	100% cohesion in grout	2.7		
Exposed / 2 Freeze + salt / thaw	1	100% cohesion in concrete	3.7	3.1	0.6
	2	100% cohesion in grout	4.0		
	3	100% cohesion in concrete	3.6		
	4	100% cohesion in concrete	2.8		
	5	100% cohesion in concrete	2.6		
Exposed / 3 Freeze + salt / thaw	1	100% cohesion in grout	2.8		
	2	100% cohesion in grout	2.9		
	3	100% cohesion in grout	2.2		
	4	failure in adhesive			
	5	failure in adhesive			

Cohesion in concrete = debonding took place in concrete, cohesion in grout = debonding took place in grout

Espoo, 29.6.2016


Hannu Hyttinen
Product Manager


Eeva-Liisa Lepistö-Saukko
Senior Expert

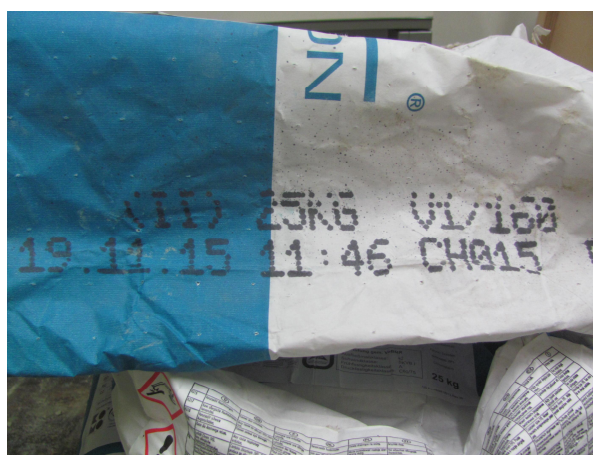
APPENDIX DISTRIBUTION

5 pcs: product information and photos of performance of the tests
Customer Original
VTT Expert Services Ltd Original

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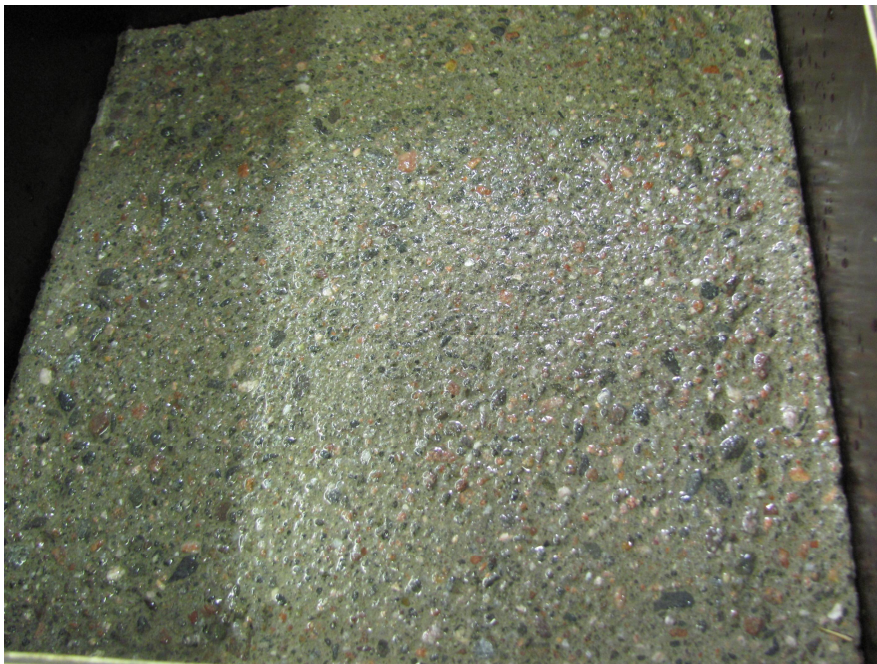
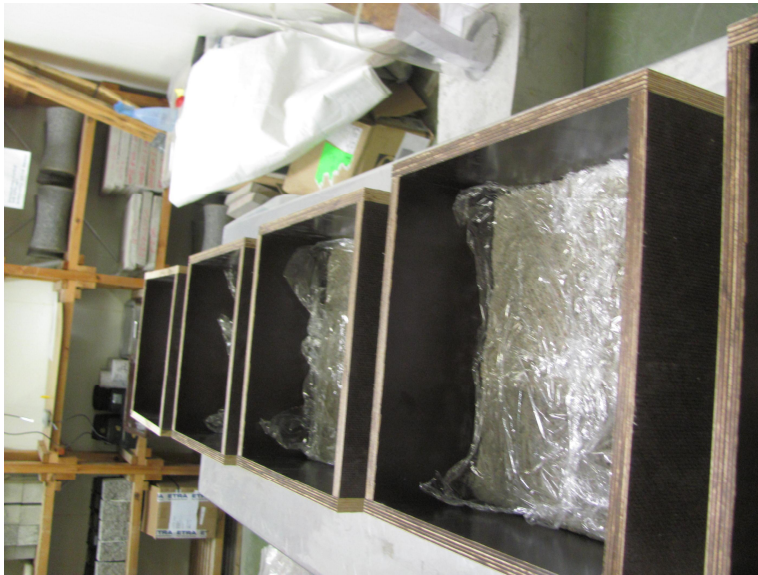
Product information on the sample pages.



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Preparing of the test specimen, molds and surface of the concrete before casting of the repair product.



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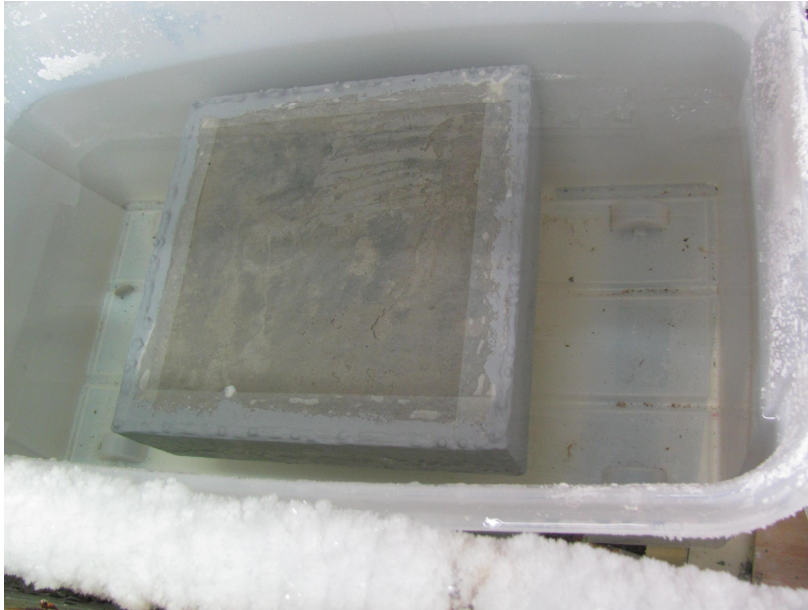
Sealing of the sides and rear of the concrete test specimens.



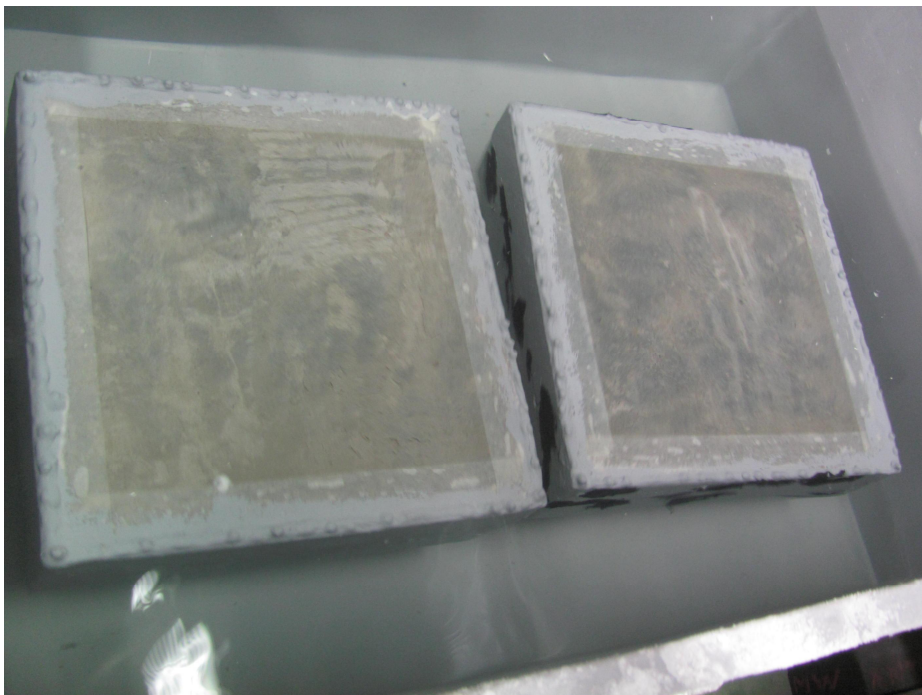
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Test procedure: Immersion in the tank containing saturated sodium chloride solution at temperature of $(-15 \pm 2)^{\circ}\text{C}$. Freezing stage.



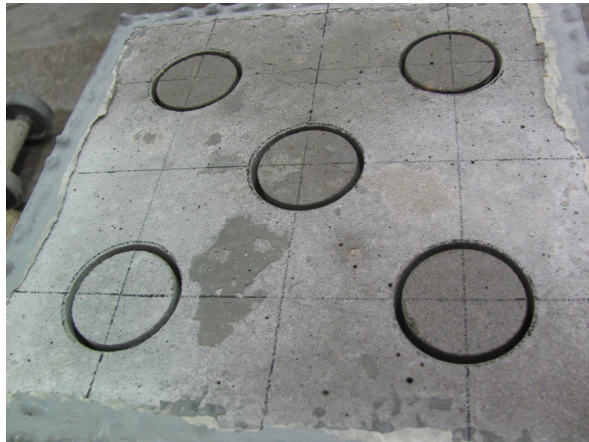
Test procedure: storage in the water tank at temperature of $(21 \pm 2)^{\circ}\text{C}$. Thaw stage.



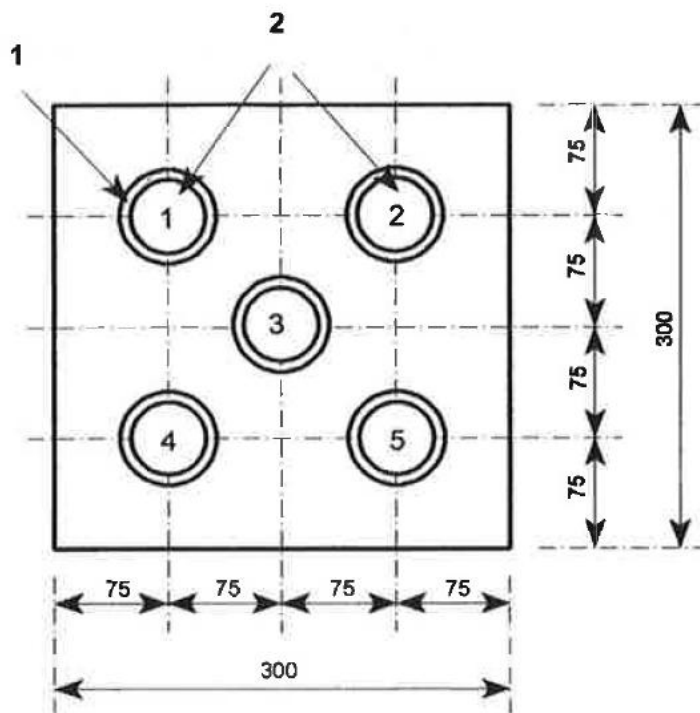
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Test piece after drilling the cores.



Drilling schema.



Key

- 1 Annulus around test area, formed by coring
- 2 50 mm diameter steel or aluminium dolly

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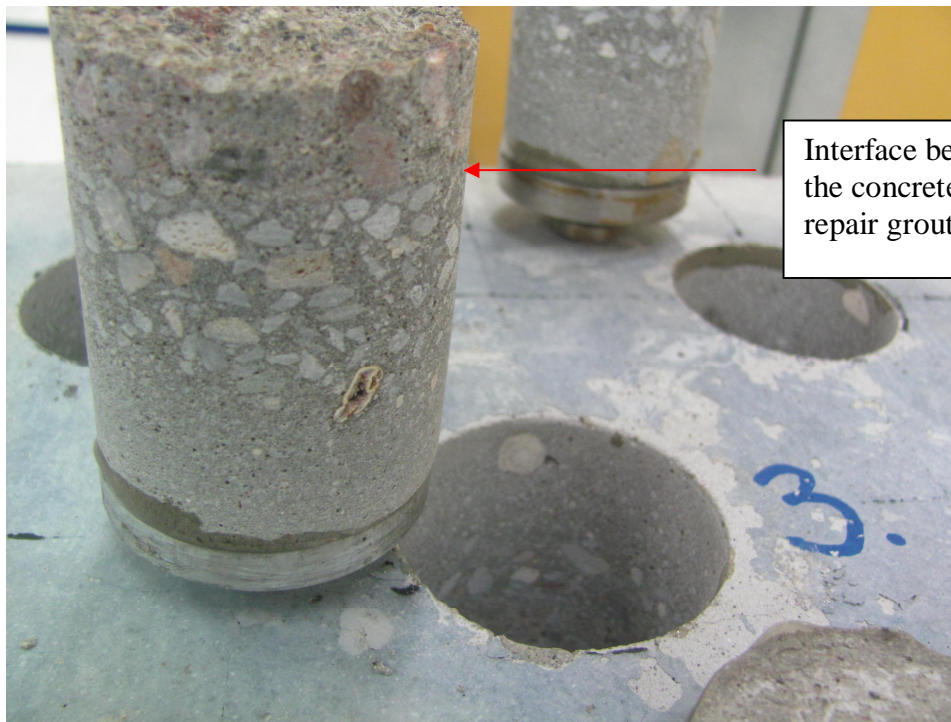
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Pull-off strength test.



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