CUSTOMER REPORT

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Concrete repair materials SILKO-tests 2017

Confidentiality: Public

Report's title

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Summary

This is an unofficial translation of the Finnish research report. In case of interpretation disputes the Finnish report.

This test programme is an updated version of the test programme VTT-CR-01175-16. Tests on fresh mix have been changed volunteer.

This test programme is to be used in examining the suitability of repair materials for the reparation of engineering concrete structures of the orderer (developer). Suitable materials are published in SILKO-directions which are available in the internet www.liikennevirasto.fi/palveluntuottajat/ohjeluettelo.

Concrete repair materials are divided in groups on the basis of their use and binder. In these instructions the cementitious products are called mortars or grouts if the maximum grain size is 4 mm and concretes if the maximum grain size is larger. The materials with only organic binder are called mastics.

Part of the SILKO-tests are obligatory and part of them are voluntary. On the bases of the results of the obligatory tests the orderer decides about the applicability of the material for the orderers projects. The voluntary tests are carried out to prove that a material has a special property suitable for a special case.

The repair material must have a CE marking, declaration of performance according to EN 1504-3 and AVCP class 2+.

Confidentiality	Public

Espoo 24.4.2017

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1. Introduction

These test instructions are to be used in examining the suitability of repair materials for the reparation of engineering concrete structures of the orderer (developer). The repair material must be CE marked having the declaration of performance according to EN 1504-3 (AVCP 2+). These instructions concern pre-mixed dry concretes, patch mortars and mastics, jointing grouts and mastics, screeds, pre-mixed shotcretes and air-blown mortars. The test programme is prepared corresponding to Finnish outdoor environments using as much European test standards as possible. On the bases of the test results the orderer decides about the applicability of the material for the orderers projects. The suitable materials are published in SILKO-directions which are available in the internet www.liikennevirasto.fi/palveluntuottajat/ohjeluettelo.

The test specimens for SILKO-tests are prepared by the representative of the product manufacturer under the surveillance of the test laboratory. The tests on fresh mixture are carried out by the test laboratory personnel in the presence of the representative of the product manufacturer. Any exception to this procedure should be noted in the test report.

2. Product groups and their test programmes

Concrete repair materials are divided in groups on the basis of their use and binder. In these instructions the cementitious products are called mortars or grouts if the maximum grain size is 4 mm and concretes if the maximum grain size is larger. The materials with only organic binder are called mastics.

Part of the SILKO-tests are obligatory and part of them are voluntary. The obligatory tests must be carried out to study the applicability of the material on the projects of the orderer. The voluntary tests are carried out to prove that a material has a special property suitable for a special case. The properties of different groups of materials that are tested are listed in Table 1, along with the test methods.

Other than the European test methods of the test programme are described in chapters 3, 4 and 5.

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Table 1. Tests. P = Obligatory test, V = Voluntary test.

Property	Test	Pre-mixed dry concretes	Pre-mixed dry shotcretes, air-blown mortars	Patch mortars	Patch mastics	Jointing grouts	Jointing mastics	Screeds	Critetion
Components									
Chloride content	EN 1015-17	P	P	P	P	P	P	P	≤ 0.05 %
Fresh mix									
Consistency	EN 13395-1, 10/ 30 min (tixotropic materials) or EN 13395-2, 5/ 15/ 30/ 60 min			V	V	V	V	V	No criterion No classification Numeric result in SILKO
	EN 13395-3	V							
Air content 5/ 30 min	EN 12350-7	V							- ” -
	EN 1015-7			V		V		V [1)]	
Density 5/ 30 min	EN 12350-6	V		V		V		V	- ” -
	EN 1015-6			V		V		V	
Bleeding	EN 480-4	V		V		V		V	- ” -
	Modified EN 480-4(Chapter 3)								
Setting Time	EN 13294 Start/ End	V		V					- ” -
Temperature 5 min	Calibrated thermometer	V		V		V		V	- ” -
Washout resistance	BS 8443:2005			P [3)]	P [3)]				< 15 %
	Funnel test (chapter 5.1)					P [3)]	P [3)]		The wash-out mass loss ≤ 2 vol-%
	SILKO test (chapters 5.2)	P [3)]							Water must remain clear
Hardened material									
Compressive strength 7/ 28/ (91) d 7and 28 d are obligatory	EN 12190			P	P	P	P	P	≥10 MPa No classification Numeric result in SILKO
	EN 12390-3	P	P						
Density 7/ 28 d	EN 12390-7	P	P	P	P	P	P	P	No criterion No classification Numeric result in SILKO
	EN 12190			P	P	P	P	P	

continues

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Table 1. Continued

Property	Test	Pre-mixed dry concretes	Pre-mixed dry shotcretes, air-blown mortars	Patch mortars	Patch mastics	Jointing grouts	Jointing mastics	Screeds	Critetion
Carbonation (Structures above water level)	EN 13295	P	P	P		V			+ ≤ 10 mm ++ ≤ 5 mm +++ ≤ 2 mm
Frost-salt durability and the effect of freezing and thawing on the adhesion	EN 13687-1 When testing materials for underwater reparations following deviations from the standard are made: • Material is applied on the concrete substrate immediately after removal from water • Specimens are submerged in water immediately after application of the material and cured in water until the start of freeze-thaw cycling EN 1542	P 2)	P 2)	P 2)	P 2)	P 2)	P 2)	P 2)	After 50 cycles a) +++ No cracking or lamination b) bond to concrete + ≥ 0.8 MPa In cohesion failure ≥ 0.5 MPa ++ ≥ 1.5 MPa +++ ≥ 2 MPa Total result = average (a + b)
Bond to the concrete and tendency to sag	EN 1542 When testing materials for underwater reparations following deviations from the standard are made: • Material is applied on the concrete substrate immediately after removal from water • Specimens are submerged in water immediately after application of the material and cured in water until the adhesion test	P	P	P	P	P	P	P	+ ≥ 0.8 MPa In cohesion failure ≥ 0.5 MPa ++ ≥ 1.5 MPa +++ ≥ 2 MPa

continues

EN

Table 1. Continued

Property	Test	Premixed dry concretes	Premixed dry shotcretes, air-blown mortars	Patch mortars	Patch mastics	Jointing grouts	Jointing mastics	Screeds	Critetion
Restrained shrinkage underwater	EN 12617-4 Wet substrate. Deviations from standard: • Material is applied on the concrete substrate immediately after removal from water • Specimens are submerged in water immediately after application of the material EN1542	P [3]	P [3]	P [3]	P [3]	P [3]	P [3]	P [3]	After the test: a) +++ No cracking of lamination b) bond to concrete + ≥ 0.8 MPa In cohesion failure ≥ 0.5 MPa ++ ≥ 1.5 MPa +++ ≥ 2 MPa Total result = average (a + b)
Wear resistance (Structures above water level)	EN 12697-16-A	V [4]				V [4]	V [4]		+ ≤ 38 cm^3 ++ ≤ 30 cm^3 +++ ≤ 22 cm^3 The abrasion classification is according to the valid asphalt standard.
Abrasion resistance (Structures below water level)	ASTMC1138M-05 (Reapproved 2010)	P [3]	P [3]	P [3]	P [3]	P [3]	P [3]	P [3]	+ 3,0---6,0 vol-%/ 48 h ++ 1,5…3,0 vol-%/ 48 h +++ ≤ 1,5 vol-%/48 h
Colour and darkness	Method described in section 4.1 or visual estimation	V [5]	V [5]	V [5]	V [5]	V [5]	V [5]	V [5]	No criterion No classification Numeric result in SILKO
Chloride penetration	EN 13396	V	V	V	V	V	V	V	-
Overhead application	EN 13395-4 (Ref. concrete MC (0,40))	V [4]	V [4]	V [4]	V [4]	V [4]	V [4]	V [4]	+ ≥ 0.8 MPa In cohesion failure ≥ 0.5 MPa ++ ≥ 1.5 MPa +++ ≥ 2 MPa

[1] If the test can be carried out.
[2] Obligatory also for materials for underwater repairs if the material is used for such parts that are exposed to frost.
[3] Obligatory for materials for underwater repairs
[4] Voluntary for materials for repairs of structures above water level
[5] Voluntary for materials used for visible parts of structures

3. Bleeding of mortars, grouts and screeds

3.1 Principle

The principle of the test is the same as that of EN 180-4 but the dimensions of the measuring vessel are different.

3.2 Test procedure

The measuring vessel has vertical borders and the area of its bottom is 300 - 40000 mm^2. At least 100 mm high layer of the material to be studied is placed in the vessel and compacted according to manufacturer´s instructions. The vessel containing the material is weighed. The vessel is sealed tightly to prevent water from evaporating. The vessel is placed in a calm place free of vibration. After 2 hours the water accumulated on the surface is drawn off using a pipette or similar instrument or by tilting the vessel carefully. Weigh the vessel after removing he bleed water. Calculate the mass of bleeding water.

3.3 Test results

Bleeding water as a percentage of the total amount of water in material is given as test result.

4. Colour and darkness

4.1 Principle

The darkness of the mould and cast surfaces are measured using colour meter based on CIELAB colour system. The colour tone is evaluated visually and described verbally.

4.2 Test procedure

The darkness of the mould and cast surfaces of the specimen cured for at least 7 days at a relative humidity of 65 ± 5% at a temperature of 20 ± 2 ºC are measured. The measurements are carried out at least at two not overlapping spots the diameter of which is at least 50 mm. CIE standard illuminant D_{65} is used as light source. The colour meter sends ambient light and measures the light reflecting perpendicularly from the surface.

The visual evaluation of the colour is done in daylight or under the light of two colour control lamps the wattage and the colour rendering index of which are 58 W and 98 respectively. The distance of the lamps from the surface is ca 0,5 m.

The specimens are photographed.

4.3 Test results

The darkness of the mould and cast surfaces as lightness of CIELAB colour system in which 0 = black and 100 = white as well as the colour evaluation and photographs of the specimens are given as the test results.

5. Washout resistance

5.1 Jointing grouts and jointing mastics /1/

5.1.1 Principle

The grout or mastic is poured through a funnel into a beaker containing an equivalent volume of water. The wash-out mass loss is measured.

5.1.2 Test procedure

The bottom of the funnel is positioned at 10 mm above the water level of the beaker. With the funnel plugged at the bottom, 500 ml of the material to be studied is poured into the funnel. The plug is removed and the material falls freely into the beaker containing 500 ml of water.

The wash-out mass loss is determined by calculating the difference in the mass of the material sample before and after dropping it in water and is expressed as a percentage of the mass of the initial 500-ml material sample.

$$\text{Wash-out mass loss} = 100\ (V_{tot} - V_n)/\ V_{tot} \qquad (\%)$$

where V_{tot} = 500 ml and
V_n = volume of material (ml) in the beaker after the test.

Test arrangement is shown in Figure 1.

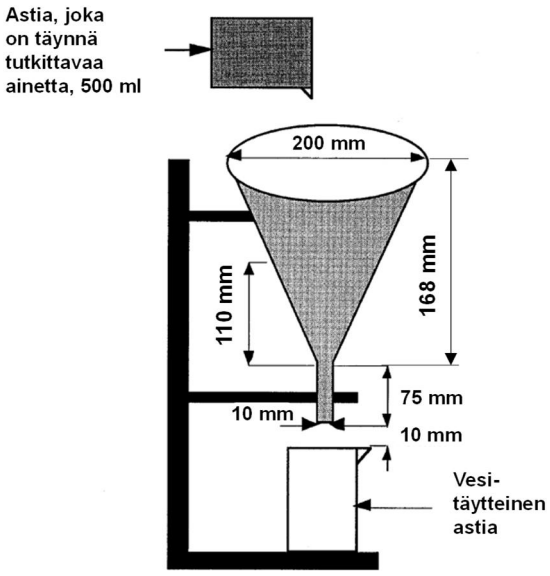

Figure 1. Test arrangement of funnel test.

5.1.3 Test results

The average of three wash-out mass loss test results as percentage of the original volume is given.

5.2 Premixed dry concretes

5.2.1 Principle

The tendency of a fresh mix to wash-out during underwater casting is measured.

5.2.2 Test procedure

The wash-out tendency is determined by means of a test where a steel mesh container is filled with the material and dropped through a layer of water. The container should be filled within three minutes from the end of mixing. The container is then repeatedly dropped five times through a 140 cm water depth. At the end of the test the weight loss from the material is determined. The total test series is repeated three times. The test arrangement is presented in Figure 2.

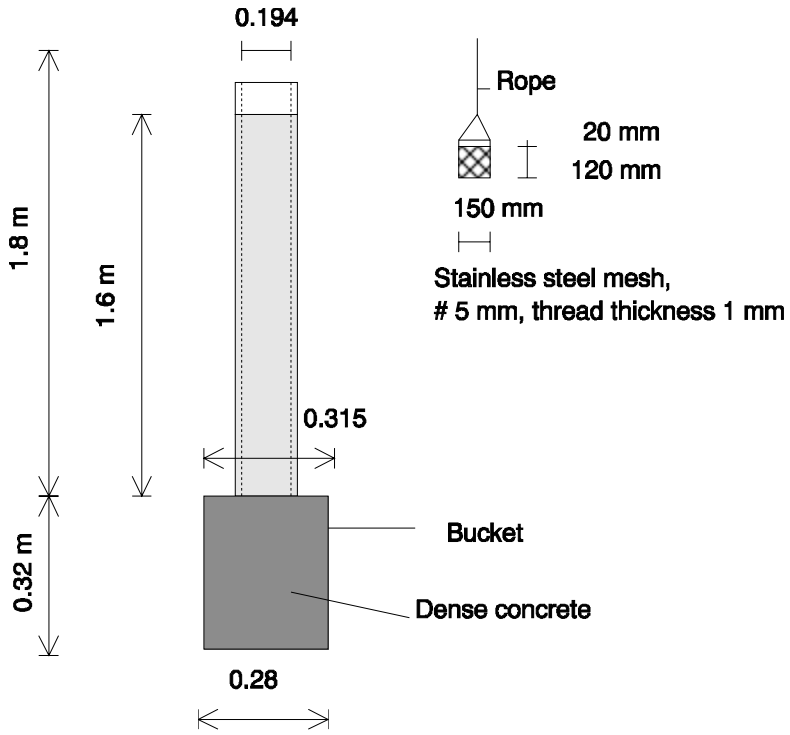

Figure 2. Arrangement for the testing of the material's tendency to wash out - pre-mixed concretes, patch mortars, patch mastics, jointing grouts, jointing mastics and screeds.

5.2.3 Test results

The percentage weight loss as an average of the three test series is reported.

6. References

1. Khayat, K. H. and Yahia, A. 1998. Simple field tests to characterize fluidity and washout resistance of structural cement grout, Cement Concrete & Aggregate, Vol. 20, N:o 1, s. 145 - 156.