

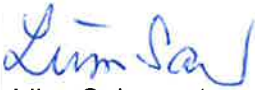


## RESEARCH REPORT

VTT-R-01277-14/EN  
REPLACES RESEARCH REPORT NR VTT-R-07409-11/EN

# Concrete repair materials SILKO-tests 2014

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Confidentiality: Public

<b>Report's title</b> Concrete repair materials, SILKO-tests 2014	
<b>Customer, contact person, address</b> Finnish Transport Agency, Helsinki	<b>Order reference</b> -
<b>Project name</b> Concrete technological studies 2013	<b>Project number/Short name</b> 82372/BTT 2013
<b>Author(s)</b> Liisa Salparanta	<b>Pages</b> 8 p.
<b>Keywords</b> Concrete, repair, mortar, grout, screed, sprayed concrete	<b>Report identification code</b> VTT-R-01277-14/EN
<b>Summary</b> <p>This is an unofficial translation of the Finnish research report. In case of interpretation disputes the Finnish report.</p> <p>These test instructions are to be used in examining the suitability of repair materials for outdoor concrete structures owned by Finnish Transport Agency. On the basis of test results Finnish Transport Agency decides on the acceptability of repair materials for their use. The approved materials are published in SILKO-directions which are available on the web pages of <a href="http://portal.liikennevirasto.fi/sivu/www/f/urakoitsijat_suunnittelijat/vaylanpidon_ohjeet/sillat/ko_rjausohjeet/SILKO">http://portal.liikennevirasto.fi/sivu/www/f/urakoitsijat_suunnittelijat/vaylanpidon_ohjeet/sillat/ko_rjausohjeet/SILKO</a>. This test programme has been valid since 2007 and it was written out as publication and translated in English in 2009.</p> <p>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.</p> <p>Part of the SILKO-tests are obligatory and part of them are voluntary. The obligatory tests must be carried out on all repair materials for which the acceptance by Finnish Transport Agency is applied for. The voluntary tests are carried out to prove that a material has a special property suitable for a special case.</p>	
<b>Confidentiality</b>	Public
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## 1. Introduction

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These test instructions are to be used in examining the suitability of repair materials for the reparation of outdoor concrete structures owned by Finnish Transport Agency. 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 typical Finnish bridge environments using as much European test standards as possible. On the basis of test results Finnish Transport Agency decides on the acceptability of repair materials for their use. The approved materials are published in SILKO-directions which are available on the web pages of Finnish Transport Agency, <http://alk.tiehallinto.fi/sillat/silko/silko1.htm>.

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

## 2. Product groups and their test programmes

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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 on all the materials that are applied for acceptance by Finnish Transport Agency. 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 4 and 5.

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	Criterion
Components									
Product identification	IR EN 1767	P <sup>1)</sup>	P <sup>1)</sup>	P <sup>1)</sup>	P	P <sup>1)</sup>	P	P <sup>1)</sup>	
	XRD	P	P	P	P	P		P	
Chloride content	EN 1015-17	P	P	P	P	P	P	P	≤ 0.05 %
Fresh mix									
Consistency	EN 13395-1 (ixotropic materials))			P	P	P	P	P	No criterion No classification Numeric result in SILKO
	EN 13395-2								- " -
	EN 13395-3	P						P <sup>2)</sup>	- " -
Air content	EN 12350-7	P		P		P			- " -
Density	EN 12350-6	P		P		P			- " -
Bleeding	EN 480-4	P		P		P			- " -
Setting Time	EN 13294	P		P					- " -
Temperature	Calibrated thermometer	P		P		P			- " -
Hardened material									
Compressive strength	EN 12190			P	P	P	P	P	≥10 MPa No classification Numeric result in SILKO
	EN 12390-3	P	P						- " -
Density	EN 12390-7	P	P	P	P	P	P	P	No criterion No classification Numeric result in SILKO
Carbonation	EN 13295	P	P	P	P	V			+ ≤ 10 mm ++ ≤ 5 mm +++ ≤ 2 mm
Colour and darkness	SS 81 20 03	P	P	P	P	P	P		No criterion No classification Numeric result in SILKO

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	Criterion
Frost-salt durability and the effect of freezing and thawing on the adhesion	EN 13687-1	P	P	P	P	P	P	P	Average crack width $\leq 0,05$ mm No crack $\geq 0,1$ mm. No lamination. a) + scaling $\leq 2$ mm, $> 60$ % of surface ++ scaling $\leq 1$ mm, $20$ % $\leq x \leq 60$ % of surface +++ scaling $\leq 0,5$ mm, $< 20$ % of surface b) Bond after 50 cycles: + $\geq 0,8$ MPa ++ $\geq 1,5$ MPa +++ $\geq 2$ MPa Total result= average (a+b)
Bond to the concrete and tendency to sag	EN 1542	P	P	P	P	P	P	P	+ $\geq 0,8$ MPa In cohesion failure $\geq 0,5$ MPa ++ $\geq 1,5$ MPa +++ $\geq 2$ MPa
Applicability for underwater casting	SILKO-test	V	V	V	V	V	V	V	Weight change $\leq 2$ % Water must remain clear
Wear resistance	EN 12697-16-A	V	V	V	V	V	V	V	+ $\leq 38$ cm <sup>3</sup> ++ $\leq 30$ cm <sup>3</sup> +++ $\leq 22$ cm <sup>3</sup> The abrasion classification is according to the valid asphalt standard.
Chloride penetration	EN 13396	V	V	V	V	V	V	V	-
Overhead application	EN 13395-4 (Ref. concrete MC (0,40))	V	V	V	V	V	V	V	+ $\geq 0,8$ MPa In cohesion failure $\geq 0,5$ MPa ++ $\geq 1,5$ MPa +++ $\geq 2$ MPa

<sup>1)</sup> Obligatory for polymer containing products. <sup>2)</sup> Obligatory when the test is suitable for the product.

### **3. Tests of cement based repair materials required for the certified product declaration**

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The certified product declaration for cement based repair materials of outdoor concrete structures containing polymers not more than 25% by weight of cement is granted by the Concrete Association of Finland. The product declaration can not be applied on the basis of SILKO-tests. The full details of the required tests are presented in the form “by 9 Korjausmateriaalit” of the Concrete Association of Finland.

### **4. Colour and darkness**

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#### **4.1 Principle**

The colour and darkness of the examined surface is compared to a colour model.

#### **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  $70 \pm 5\%$  at a temperature of  $20 \pm 2$  °C are determined in daylight according to the Swedish standard SS 81 20 03. The standard colour models are pressed tightly against the specimen surface to compare the colour and darkness to the samples.

The specimens are photographed.

#### **4.3 Test results**

The darkness of the specimen surfaces expressed as blackness percentages with the accuracy of  $\pm 5\%$  as well as the colour evaluation and photographs of the specimens are given as the test results.

### **5. Applicability to underwater castings**

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#### **5.1 Pre-mixed concretes, patch mortars, patch mastics, jointing grouts, jointing mastics and screeds**

##### **5.1.1 Principle**

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

##### **5.1.2 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 1.

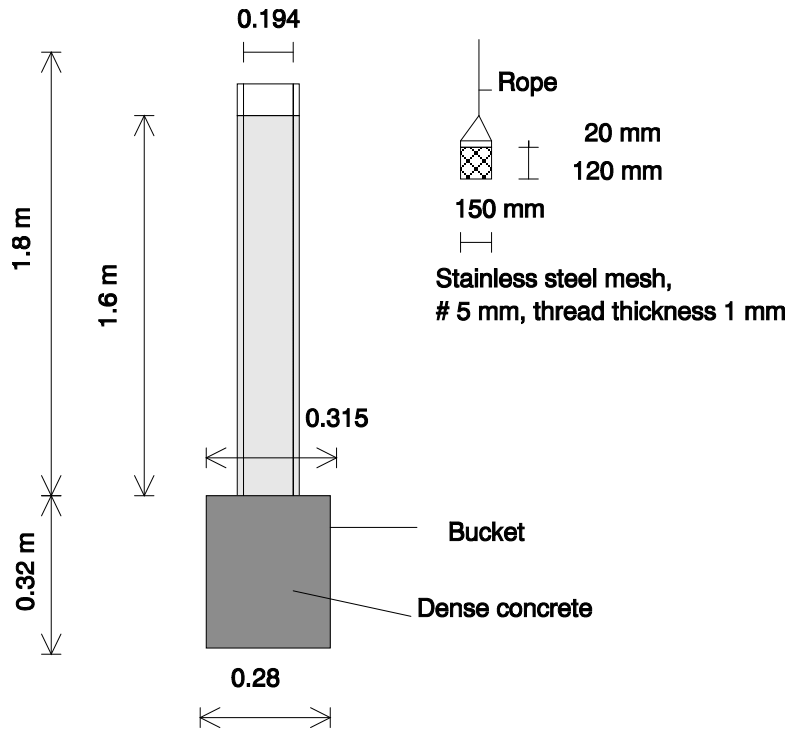


Figure 1. Arrangement for the testing of the material's tendency to wash out - pre-mixed concretes, patch mortars, patch mastics, jointing grouts, jointing mastics and screeds.

### 5.1.3 Test results

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

## 5.2 Pre-mixed dry shotcretes

### 5.2.1 Principle

The tendency of a sprayed concrete or air-blown mortar to wash-out during underwater casting is estimated visually.

### 5.2.2 Test procedure

The applicability of the material for underwater application is tested by spraying 2 litres of concrete or air-blowing mortar vertically downwards through a water depth of 140 cm. The test is photographed. The test arrangement is shown in Figure 2.

### 5.2.3 Test results

A visual estimation of the material's tendency to wash out and a photograph of performing the test are given as the test result.



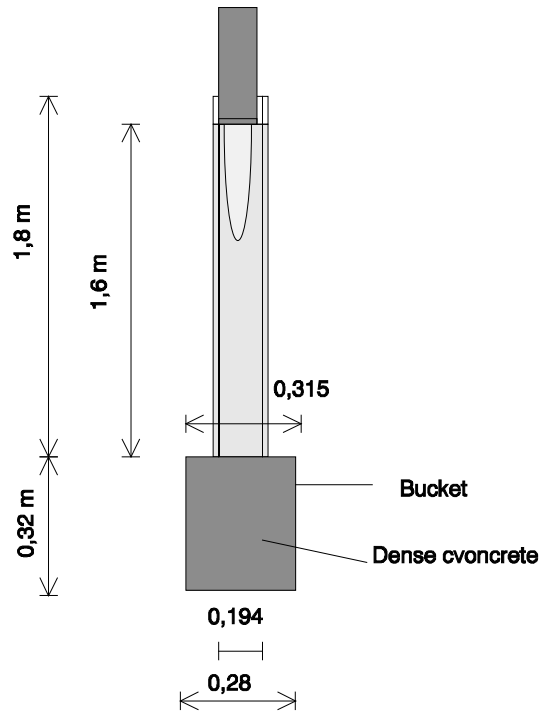


Figure 2. Arrangement for the testing of the material's tendency to wash out - pre-mixed dry shotcretes.